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NASA INFORMATION SYSTEMS MARKET

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Federal Information Systems and Service Program (FISSP)

NASA Information Systems Market

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Abstract

NASA was established as an independent agency responsible for conducting space and aeronautical activities for peaceful and scientific purposes. The agency operates in a decentralized management and program structure. Since its many research and space centers have different functions, most of the information systems planning originates at the centers in support of specific programmatic activities.

Historically, NASA has always made extensive use of contracted services in performing mission activities. INPUT has analyzed the agency's budget submissions and estimates that the contracted portion of NASA's information systems budget will increase from $910 million in 1988 to $1.3 billion in 1993, an average annual growth rate of 8.7%.

This report examines the planning and procurement processes at NASA and details some of the major information systems and programs. It also identifies several of the initiatives being developed to centralize selected administrative and mission support functions.

This report contains 168 pages, including 56 exhibits.

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Introduction

This report on the Information Systems Market within the National Aeronautics and Space Administration (NASA) was prepared as part of INPUT's Federal Information Systems and Services Program (FISSP). Many FISSP clients requested that INPUT analyze and report on Information Systems (IS, including services, hardware, and software) opportunities within NASA as one source of information supporting clients' business decisions regarding pursuit of NASA opportunities.

A Scope

This report covers an overview of the NASA agency mission and organization and their planning and acquisition process. It discusses the major programs and initiatives of the agency headquarters and research and space centers. The report also discusses the agency's current and planned use of information systems as identified through interviews with selected NASA agency officials.

The report analysis details some of the information systems opportunities listed in the OMB/GSA/NBS Five-Year Plan for government fiscal years (GFYs) 1988 to 1993, and available agency ADP Plans.

The vendors selected for interview were identified as contractors of record for ongoing programs or listed as vendors for NASA in INPUT's Company Analysis and Monitoring Service data base for 1987. The period of interest is GFY 1987 to 1993.

B Methodology

The OMB/GSA/NBS Five-Year Plan analysis and the INPUT Procurement Analysis Report were reviewed for programs to be initiated during the period of interest. The available agency plans for GFY 1987-1992 and GFY 1988-1993 were researched to identify plans for major initiatives and programs.

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The Federal Government Information Technology Budget requests provided in response to OMB Circular A-11, Sections 43A and 43B, for GFY 1987 to 1989 were analyzed to identify significant spending changes and funding levels.

Concurrently, the mission of each NASA organization was defined along with the role of IS in fulfilling this mission. INPUT analyzed discrepancies between the desired IS role and the actual IS role that would lead to an initiative for improvement.

Supporting on-site and telephone interviews were also conducted by INPUT staff. Questionnaires were developed for interviews with NASA officials and industry vendors.

- Federal agency officials selected at headquarters and space and research centers for interview included:

  - Executives (policy)
  - Contracting officers (buyers)
  - Program managers (users)

- Vendor executives selected for interview included:

  - Company executives
  - Marketing executives

Copies of the agency and vendor (industry) questionnaires are included in Appendices F and G.

- The agency questionnaire was designed to acquire information about current experience and plans for future use of information systems.

- The vendor questionnaire was designed to acquire information on agency experience, industry trends, and future technological developments.

- Both included similar questions about contracting policy and preference, selection criteria, and information services trends and issues.

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C

Report Organization

- This report consists of six chapters. These are:
  - Chapter II—an Executive Overview describing the major points and findings in the report.
  - Chapter III—covers the mission and organization of the agency, along with the structure and functions of NASA's information systems.
  - Chapter IV—provides the market forecast for each market segment of the information technology market and NASA's funding patterns.
  - Chapter V—presents the major programs and initiatives underway at the agency.
  - Chapter VI—summarizes the acquisition plans and procedures utilized by the agency.
  - Chapter VII—presents the vendors perspectives on NASA's information systems market.
- Several appendixes are also provided:
  - Interview Profiles
  - Definitions
  - Glossary of Federal Acronyms
  - Policies, Regulations, and Standards
  - Related INPUT Reports
  - Questionnaires

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Executive Overview

A NASA Centralization Initiatives

Throughout its history, NASA has used computers extensively for both administrative systems and mission support. Also, throughout its history, NASA has functioned in a highly decentralized mode. These two practices have combined to produce complex, highly effective information systems dedicated to supporting specific programs.

As this report shows, NASA has undertaken changes to require more information sharing than at any time in its history. It would be an oversimplification to suggest that NASA is centralizing its systems. Rather, in selected areas, it would be more accurate to say that NASA is moving away from its traditionally decentralized approach. Exhibit II-1 lists some examples of this change:

EXHIBIT II-1

NASA CENTRALIZATION INITIATIVES

- Software Support Environment
- Technical and Management Information Systems
- Software Management and Assurance Program
- Procurement Management Technology Program
- NASA Uniform Personnel/Payroll System

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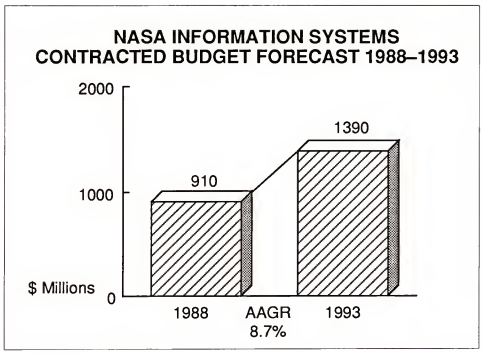
- The Software Support Environment, tied to the Space Station program, will provide an overall NASA software framework for the 1990s;
- The Technical and Management Information System will support the dissemination of Space Station information to other programs;
- The Software Management and Assurance Program (SMAP) will enhance software quality and software exchange among the various centers;
- The Procurement Management Technology Program will result in an agency wide standard automated procurement system; and
- The NASA Uniform Personnel/Payroll System will replace nonstandard, installation-unique systems, as well as the agency wide Personnel Management Information System at headquarters.

These last two systems are being developed under the Automated Information Management Program (AIM), which aims to improve the delivery of administrative and management support programs.

B
NASA Market Forecast FY 1988-1993

INPUT estimates that the contracted portion of NASA's information systems budget will grow from $910 million to $1,390 million, as shown in Exhibit II-2. This represents an Average Annual Growth Rate (AAGR) of 8.7%. Section IV contains a detailed breakout of this forecast.

EXHIBIT II-2



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As INPUT developed this report, NASA's budget status in the Congress changed frequently. Some committees voted budget cuts, while others approved agency budget proposals or even opted for specific program increases. INPUT based its forecast on NASA's A-11 budget submission and other available materials. However, should a major program, such as the Space Station, be cut or stretched out, the forecast would require some adjustment.

C Current Budget Allocation Focus

In allocating its information technology budget, NASA focuses on four primary areas. These are listed in Exhibit II-3.

EXHIBIT II-3

CURRENT BUDGET ALLOCATION FOCUS

- Intensify Automation of Highly Technical Areas
- Support Agency-Developed Software
- Increase Computer Capabilities
- Use AI for Decision Support

Historically, NASA has not always been on the leading edge of information technology. Reports from various oversight agencies have suggested a need for improvement in this area. As a result NASA has initiated a wide-ranging program to intensify its automation of highly technical areas. For example, in the telecommunications area, NASA has established several sophisticated local-area networks to facilitate information sharing.

NASA has also taken various steps to support and improve its own developed software. Section A mentioned the SMAP initiative. NASA has also established several intercenter committees to strengthen its overall software profile.

The various NASA centers are also pursuing a significant upgrade of their computer facilities. INPUT's review of NASA's most recent OMB Circular A11 Section 43B submission indicated that heavy hardware upgrades, replacements, and new starts would be taking place over the next five years.

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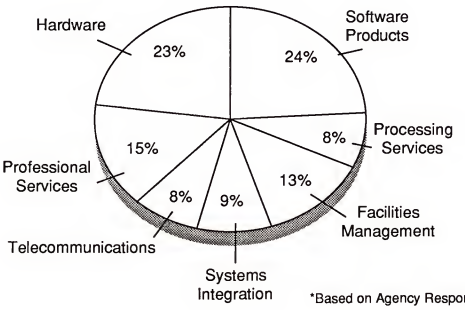
Finally, NASA has begun using artificial intelligence (AI) to enhance its decision support activities. For example when combined with graphics, AI can be used to analyze satellite data according to certain pre-established criteria. This effectively reduces the amount of analysis to be performed by humans, and also focuses that analysis.

D
Contract Services Outlay Distribution

Traditionally, NASA has used contractors more than most agencies in performing mission activities. INPUT surveyed NASA personnel at both headquarters and the centers to determine how they allocate their spending among information systems. Exhibit II-4 summarizes the results.

EXHIBIT II-4

CONTRACT SERVICES OUTLAY DISTRIBUTION*



*Based on Agency Responses

Based on interview responses, software just slightly edged out hardware. Although the difference is too small to be statistically significant (and is not reflected in the A11-43B data), it does illustrate the important role that software plays in NASA's acquisition plans.

Unlike many other agencies, NASA does not identify heavy spending for systems integration. This stems from the fact that most centers, plus headquarters, already have on-site vendors doing the integrating. For

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example, at the Kennedy Space Center, Lockheed is managing the upgrade of the Launch Processing System, including significantly improved data base capabilities. At headquarters, Planning Research Corporation performs most of the modernization efforts.

A departure from this practice is noted in the systems being acquired for the Space Station Initiative, and some of the systems that will service multiple centers in cases where outside bidders are being sought.

E

Major Information System Plans

NASA ongoing information system plans for the FY 1988 budget year and for most of the next decade focus on completing systems in place and initiating new or replacement systems that support funded missions. Emphasis is being given to two new initiatives, the Space Station and the Space Transportation System, and to activities aimed at modernizing ongoing information resources that support ongoing aerospace and orbital missions. These programs are listed in Exhibit II-5 by their acronyms, and are detailed in Section IV.

EXHIBIT II-5

MAJOR INFORMATION SYSTEM PLANS

- Space Station Systems:
  SSIS, TMIS, CDOS
- Space Transportation Systems:
  Planning, Readiness, Control
- Major Independent Systems:
  PMTP, NPPS, CNS, AIM, NAS, EADS

The Space Station Program (SSP) systems will support both the early and later phases of NASA's dominant program of the 1990s. The sheer size and complexity of the Space Station, including involvement of many contractors, most NASA Centers, and a number of international organizations, require services that support rapid, timely, and accurate interchange of information. The three main systems listed will support construction and operation of the Space Station and coordinate dissemination of scientific data.

The Space Transportation System (STS) is considered the next most important and complex NASA program. These information Systems are intended to provide data to commercial enterprises, foreign governments,

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the Defense Department, and other federal agencies. Most of these systems already exist but require modification and interfacing, and will involve 25 million lines of software code written in at least six different languages.

Independent major information systems, of which only six large systems are identified, are intended to improve intercenter data exchange, improve ongoing data processing activities, and provide NASA management with more up-to-date information for decision purposes. PMTP (Procurement Management Technology Program) will provide an agency wide standard automated procurement system.

F Component Group Growth Expectations

Independent of NASA's long-range plan observations and OMB A11 budget requests, and INPUT's own forecast, the government and vendor personnel interviewed were asked to estimate the direction and percent change in the agency's use of information service modes over the next five years. Exhibit II-6 highlights the tabulations and discussions found in Sections V and VI.

EXHIBIT II-6

COMPONENT GROUP GROWTH EXPECTATIONS

Service Mode	Annual Growth Estimates (Percent)	
	Agency	Vendor
Software	25	25
Hardware	20	32
Processing	17	7
Systems Integration	10	50

Both groups concurred in the level of increase in software contract services, at 25 percent. NASA's documentation and implementation plans emphasize the importance of software to increasing capacity and systems performance.

The two groups were farthest apart in estimating the likely growth of systems integration. The agency respondents noted that many of the system replacements will be accomplished by the current on-site contractors, rather than by new competitive bids.

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Although hardware and processing expectations were not significantly different between the groups, the differences were in different directions. Vendors expect an increase in hardware acquisition, while the agencies expect more use of contractor off-site data processing as interim measures while new systems are being implemented.

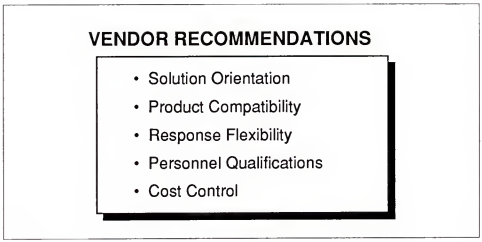
Other modes discussed in the text include professional services, telecommunications, and operational support (FM). The differences are about three to one—upward by vendors for professional services and the reverse for the other two.

G Vendor Recommendations

Examination of the contracting structure of NASA reveals concentration in the field installations/centers and headquarters of most vendor activities. Entry into the NASA market is limited to teaming or subcontracting to incumbent center contractors, bidding for recompetition of the service contracts, or bidding on the few initiatives open to competitive bidding. Some research and development contracts are awarded sole source, but only in advanced science and engineering programs.

Exhibit II-7 highlights the characteristics selected by agency personnel as key to successful contract award and retention. The most important recommendation is the need to be solution oriented, since many NASA projects are performance and schedule oriented. Product compatibility is highly significant to potential software and hardware suppliers, and includes telecommunication products. Even though NASA is not specifically name-brand sensitive, the agency does require interconnectibility.

EXHIBIT II-7



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Service providers need to espouse and offer flexible response in management, support, technical staff, and level of effort. The experimental and exploratory nature of NASA missions automatically includes a significant degree of schedule and demand uncertainty. Personnel qualifications are emphasized because of this flexible and knowledgeable response requirement. The more successful NASA vendors have a disproportionately high percentage of professionals with advanced degrees.

Cost realism and control are particularly important in the NASA environment. The agency's expenditures are extensively scrutinized and balanced against other national programs, requiring the judicious utilization of available funding by the centers and the program offices.

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Agency Overview

A Mission and Organization

NASA was established in 1958 as an independent federal agency responsible for conducting space and aeronautical activities for peaceful and scientific purposes. The principal statutory functions include: fly within and outside the Earth's atmosphere, build and operate aeronautical and space vehicles, conduct manned and unmanned space exploration, cooperate with other nations in those peaceful activities, and provide wide dissemination of information. Some of NASA's specific objectives for the next decade, as stated in its fiscal 1989 budget, are to:

- Make the agency's Space Transportation System—of which the space shuttle is a key part—fully operational and cost effective,
- Move toward the establishment of a permanently manned space station,
- Conduct an effective and productive space and earth sciences program, and
- Conduct effective and productive space applications and technology programs.

Planning, coordination, and control of NASA programs are vested in Headquarters, as indicated in Exhibit III-1. Directors of the Field Installations (Centers) are responsible for execution of NASA's programs, largely through industrial (vendor) contracts. Planning, direction, and management of NASA's research and development programs are the responsibility of five Program Offices, each headed by an associate administrator. The Program Offices and NASA Centers are separately discussed in this section.

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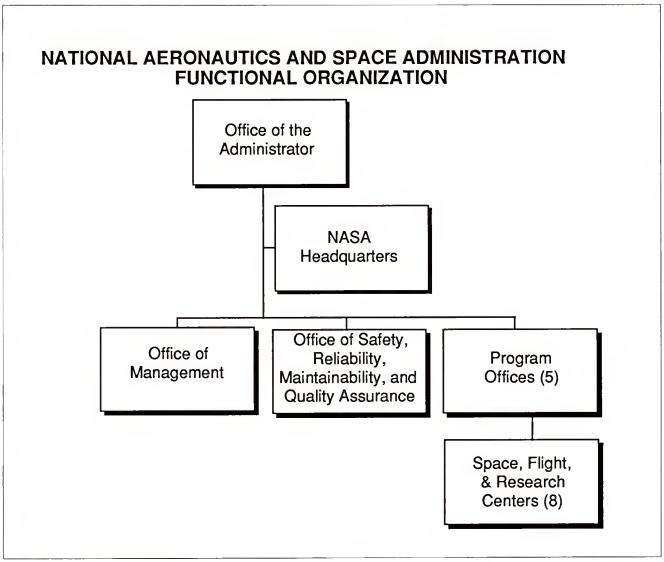
EXHIBIT III-1


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FUNCTIONAL ORGANIZATION
Office of the Administrator
NASA Headquarters
Office of Management
Office of Safety, Reliability, Maintainability, and Quality Assurance
Program Offices (5)
Space, Flight, & Research Centers (8)

The administrator, Dr. James Fletcher, and his deputy, Dale Myers, are supported by a headquarters staff that includes Central Procurement and the Commercial Programs offices, which play key roles in establishing contracting procedures and policy. The Office of Management; and the Office of Safety, Reliability, Maintainability, and Quality Assurance are also headed by associate administrators, in support of the Program Offices. An overview of the organizational structure at NASA headquarters is shown in Exhibit III-2.

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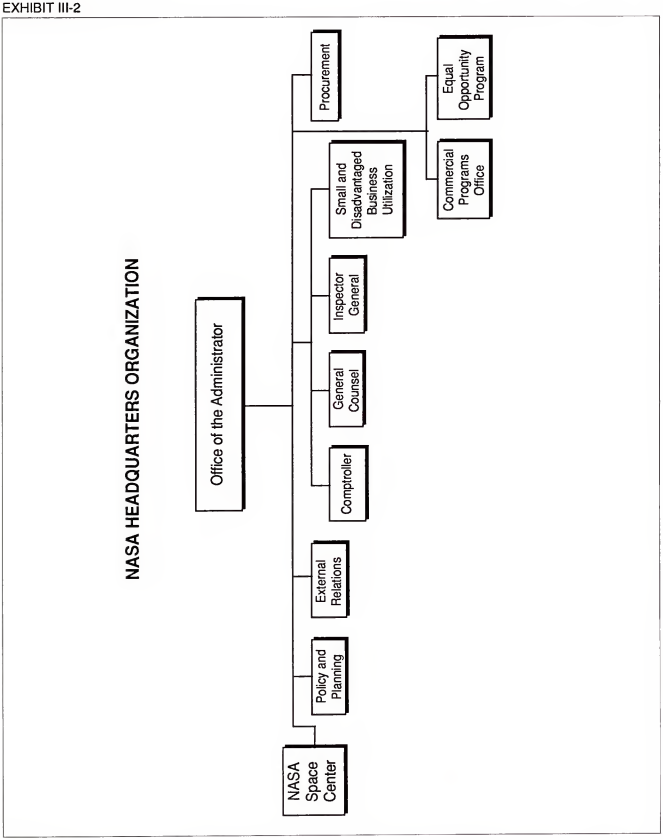
EXHIBIT III-2



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1. Program Structure

The planning, direction, and management of NASA's research and development programs are the responsibility of five program offices. The offices report to and receive overall guidance and direction from the agency Administrator. The five program offices and their major responsibilities are as follows:

a. The Office of Aeronautics and Space Technology is responsible for coordinating and conducting programs to develop advanced research and technologies for pursuit of national objectives in aeronautics and space. It also handles the application of NASA capabilities and facilities to other federal agencies and the U.S. aerospace industry.

b. The Office of Space Science and Applications is responsible for efforts by NASA to undertake its study of the universe, solar system, and integrated evolution of the planet earth. The office conducts activities and research in remote sensing, microgravity, and space communications. It also coordinates contact with other U.S. scientific advisory organizations.

c. The Office of Space Flight is responsible for handling the space shuttle program and other space transportation programs. The Office develops and operates the Space Transportation System. It also manages and directs all launch activities and the development, procurement, and operation of the U.S. Spacelab.

d. The Office of Space Operations is responsible for tracking, command, telemetry, and data acquisition support to NASA programs, which include Earth-orbital science and application missions, planetary missions, research aircraft, and the Space Transportation System. It maintains a global communications system to link facilities that provide data processing for mission control and telemetry for space missions.

e. The Office of Space Station is responsible for the overall policy and management of all components of the national Space Station Program. It directs the program in order to achieve the Presidential goals of development of a permanently manned space station, involvement of other countries as participants in the program, and promotion of the private sector in the space program through enhanced space-based operational capabilities.

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Three of the program offices at NASA headquarters oversee NASA's research and flight centers. Exhibit III-3 is an organizational chart that illustrates the associate administrator to which each space center and research center is reporting.

The Office of Aeronautics and Space Technology has institutional responsibility for the three research centers and supports the space flight centers in areas essential to the Space R&T program. It distributes the work of the Space R&T program according to the capabilities for specialized research established at each field center. The space flight centers that support flight development programs and operations are managed by the Office for Space Flight.

NASA has two organizations that oversee the use of information technology: the Information Resources Management Division (within the Office of Management) and the Software Management and Assurance Program (within the Office of Safety, Reliability, Maintainability, and Quality Assurance).

The Associate Administrator for Management is responsible for issuing policy guidance on the management of information technology. One form of this guidance, a handbook that is reviewed annually and updated as needed, lists procedures, policies, and responsibilities for the planning and acquisition of such technology. This provides agency wide guidance for planning the development of information technology and monitoring hardware and software acquisitions.

Additionally, the Office of Management prepares an annual long-range plan, which contains proposed resource acquisitions for the next 5 years. This plan is not regarded by NASA as a commitment document, and the numbers it contains are subject to change.

2. NASA Centers

Nine Field Installations or Centers support NASA activities. Each Center performs (relatively) unique functions, often on different programs, in support of NASA's overall mission. The relationship between each center and its principal program is illustrated in Exhibit III-3.

a. The Lyndon B. Johnson Space Center (JSC), located in Houston Texas, manages the development and operation of the space shuttle. NASA expects the shuttle to reduce the cost of using space for commercial, scientific, and defense needs. The Johnson Space Center oversees

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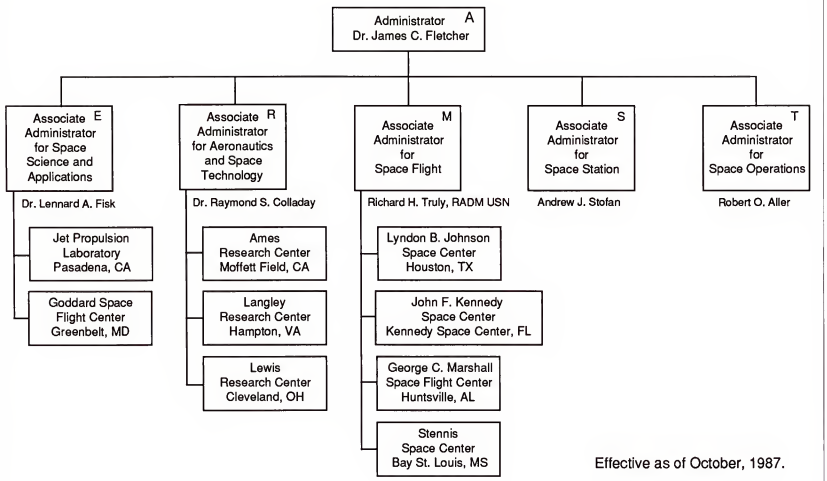
NASA PROGRAM OFFICES ORGANIZATION


Administrator A
Dr. James C. Fletcher
Associate E Administrator for Space Science and Applications
Dr. Lennard A. Fisk
Jet Propulsion Laboratory Pasadena, CA
Goddard Space Flight Center Greenbelt, MD
Associate R Administrator for Aeronautics and Space Technology
Dr. Raymond S. Colladay
Ames Research Center Moffett Field, CA
Langley Research Center Hampton, VA
Lewis Research Center Cleveland, OH
Associate M Administrator for Space Flight
Richard H. Truly, RADM USN
Lyndon B. Johnson Space Center Houston, TX
John F. Kennedy Space Center Kennedy Space Center, FL
George C. Marshall Space Flight Center Huntsville, AL
Stennis Space Center Bay St. Louis, MS
Associate S Administrator for Space Station
Andrew J. Stofan
Associate T Administrator for Space Operations
Robert O. Aller

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development of the orbiter vehicle, the portion of the shuttle that carries crews and experiments into space. Johnson also directs the design, development, and testing of spaceflight payloads and associated systems for manned flight. Johnson serves as the lead center for the Space Shuttle Program, providing technical and programmatic management in the areas of system engineering and integration, business management, operations, customer integration, and accommodation.

Johnson uses all the usual types of information systems support except for processing services. It has at least 13 major contracts in the professional services area, as well as five major telecommunications contracts. Johnson will be acquiring numerous mainframe systems over the next few years, as documented in its A-11 submission. Some of the largest purchases relate to the Mission Control Center, the Central Computing Facility, the Shuttle Mission Simulator, and the Shuttle Avionics Integration Laboratory.

The Johnson Information Technology System Plan, (December, 1987) details the IS activities for each major directorate, as well as discusses 26 major requirements and actions. It also covers some activities at the White Sands Test Facility, which is administratively associated with Johnson. (This plan is available for review at the INPUT facility in Vienna, Virginia.)

b. The Ames Research Center (ARC), located at Moffett Field, California, focuses on more arcane areas, including:

- Fundamental aerodynamics,
- Rotor craft,
- Flight dynamics research,
- Guidance control systems, and
- Computational fluid dynamics research

Ames takes the lead for NASA in computer sciences and computational modeling research, including artificial intelligence. It also actively pursues human factors research, including life support systems, life sciences research, space biological and biomedical research, and man-machine systems.

Just as in the case with Johnson, Ames uses all the usual types of information support—except for processing services. It spends the bulk of its dollars on professional services, with hardware costs coming in second.

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Our view of the Ames OMB A-11 budget submission shows heavy expenditures for communications systems. Ames has also initiated major activities in office automation, microcomputers, and intelligent workstations.

c. The Goddard Space Flight Center (GSFC), located in Greenbelt, Maryland, supports:

- Earth orbital spacecraft development,
- Tracking and data acquisition systems,
- Spacelab payloads,
- Earth dynamics, resources, and communications, and
- Planetary science research.

Goddard's proximity to NASA headquarters in downtown Washington has led to more frequent job transfers between the two sites, resulting in a more agency wide view among Goddard executives.

Unlike the two previous centers, Goddard uses some processing services, although this forms a very small part of the overall information services budget. Goddard spends much effort on software and related services, with heavy effort also on facilities management and hardware. Goddard's hardware expenditures focus mainly on independent scientific systems. However, the Goddard OMB A-11 budget submission also shows much spending for services, maintenance, and software license fees.

In a major initiative, Goddard recently awarded a $165.2 million contract to a team including McDonnell Douglas, Computer Sciences Corporation, and EER Systems. The Flight Projects Directorate Multidiscipline Support Services (FPDMSS) is expected to add 400 new jobs to the Goddard area, and includes such areas as engineering, project control, logistics, satellite programs, orbiting platforms, and large scientific instruments. There are two other companies with small pieces of the business: Swales & Associates with 7%, and Northrop Services with 2%.

A recent press report indicated that Goddard has had a major impact on the local economy. In FY 1987, Goddard obligated approximately $1.2 billion in contracts. Locally this total broke out as follows:

- $571 million to Maryland contractors;
- $36.7 million to Virginia contractors; and
- $6.1 million to D.C. contractors.

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The remaining contracts went to other areas. Goddard employs about 3,600 civil service personnel and 5,000 contractor employees.

Last October, Goddard established the Center for Excellence in Space Data and Information Sciences. This facility will allow researchers from leading university and industry computer science department to work on NASA problems at their home institutions and to share their experiences via communications network meetings.

d. The Jet Propulsion Laboratory (JPL), in Pasadena, California, functions a bit differently from the other centers. The California Institute of Technology operates the site under contract to NASA. JPL focuses on planetary spacecraft development and mission operations, lunar planetary science, energy technology for space applications, and space astronomy payloads. JPL also performs research on information systems and data acquisition systems technology.

JPL performs limited contracting activity in facilities management and processing services. JPL, as a contracted facility, is not strictly subject to the FIPS PUBs or other government standards. However, where appropriate, it does observe these standards in order to foster compatibility with other NASA centers. Despite its status as a contracted facility, it does submit OMB A-11 budget data for its five-year acquisition plans. INPUT has, therefore, included it in the NASA market forecast. The A-11 shows heavy hardware purchases for communications and control systems, as well as upgrades to most installed mainframes. Apparently, JPL will also be buying numerous embedded computer systems over the next five years.

e. The John F. Kennedy Space Center (KSC), in Florida, designs, constructs, operates, and maintains space vehicle facilities and ground support equipment for launch and recovery operations. Kennedy also recovers and refurbishes the reusable solid rocket booster.

To accomplish its mission, KSC has organized into two operational directorates, one for STS and one for Payloads, plus an Engineering Development Directorate and a Center Support Operations Directorate. The contracting structure at the center is similarly organized into two operational contractors: a Shuttle Processing Contractor (SPC) responsible for STS processing and launch support and a Payload Ground Operations Contractor (PGOC) responsible for payload processing, including Space Station. In addition, the Base Operations Contractor

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(BOC) supports base operations, and the Engineering Support Contractor (ESC) is responsible for technology and engineering laboratory support.

Like other NASA centers, Kennedy contracts little for facilities management and processing services. It also uses comparatively few systems integration contracts, instead relying on internal contractors for that sort of work. For example, Kennedy intends to replace some of its Honeywell equipment with a new system at up to ten times the processing power. This shuttle Processing Data Management System II will include relational data base capability and significantly greater functionality. Lockheed is doing the procurement for Kennedy, and will retain much of the professional services, including application conversion, for itself.

Kennedy expects to contract directly for software and related services to a higher degree than any of the other information services categories. Kennedy has also budgeted heavily for office automation.

f. The Langley Research Center (LaRC), in Hampton, Virginia, focuses on various types of aircraft technology; aerospace vehicle acoustics, structures, and materials; space electronics and control systems; and atmospheric sciences. It also engages in computer science research, including fault-tolerant systems.

Unlike most other NASA centers, Langley does use some processing services contracts, although this includes a relatively small part of the overall budget. Also, the A-11 shows a much smaller percentage of hardware buys. The biggest single line item, for analysis and programming support, ranges from $13.8 million in FY 88 to $18.4 million in FY 93. Much of this will go to maintain or enhance existing systems supporting Langley's aeronautics activities.

Aeronautics accounts for approximately 60% of Langley's budget, but the center has also produced breakthroughs in space transportation systems, electronics, atmospherics, acoustics, information systems and materials, structures, physics, chemistry, optics, and instrumentation. As described in Section IV.D., Langley has also developed a sophisticated local-area network, with a token-ring, fiber-optic backbone.

g. The Lewis Research Center, (LeRC), in Cleveland, Ohio, focuses on space propulsion systems, aeroelasticity and structural dynamics, fuels and combustion, engine instrumentation, and engine computational fluid dynamics. It is also concerned with space communication issues.

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Like most of the other centers, Lewis does not contract for processing services. However, it does use all the other standard contractor support areas. For example, EDS currently has a major systems integration contract at Lewis. In addition to supercomputers and traditional mainframes, Lewis uses VAX clusters extensively.

The Lewis OMB A-11 budget shows an extraordinarily high level of purchase plans for data entry equipment and software. There are also numerous entries on hardware, software, and services associated with supercomputers.

h. The George C. Marshall Space Flight Center (MSFC) operates at the Army's Redstone Arsenal facility in Huntsville, Alabama. It manages, develops, and tests the space shuttle's main engines and associated fuel systems. It also manages both the spacelab and space telescope programs. Marshall supports NASA programs in electronics, guidance, navigation, and control.

Like most of the other centers, Marshall does not contract for processing services. However, it does use all the other standard contractor support areas. Marshall takes advantage of third-party software packages for many mainframe and midsize applications. Grumman Data Systems currently supports system integration activities at Marshall.

Marshall's OMB A-11 budget submission shows an unusually high level of spending for facilities management support. Evidently, consulting also plays a major role at Marshall. For example, one single entry—ADP studies in support of flight hardware and Spacelab operations—is projected to cost more than $20 million FY89. Spending will continue at almost that level through FY93.

i. The Stennis Space Center (formerly the National Space Technology Laboratories; NSTL), in Bay St. Louis, Mississippi, plans and manages research and terrestrial applications, as well as space flight. It also performs research in oceanography, meteorology, and environmental sciences. Stennis also coordinates research between NASA and other governmental agencies.

Stennis uses all types of contractor support through its use of facilities management and processing services. Much of its funding is provided on a cost-reimbursable basis from other NASA Centers and various government agencies. Therefore, some of Stennis's initiatives would not appear

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in the OMB A-11 budget submission. Stennis expects a sharp increase in its contracting for telecommunications support. For example, the center is currently upgrading the Navy's Satellite Center in Monterey, California. Stennis also reports that its science program has slowed somewhat as a result of the Challenger incident, particularly in terms of a decrease in rocket testing.

Because of NASA's decentralized approach, Stennis Space Center, despite its relatively small size, has sufficient authority to conduct most of its own procurements. This acquisition process forms a major part of the Stennis operation. It has been reported that, because of its Saturn rocket support, the center's need for precision and accuracy has grown sharply. Its computer and telecommunications applications support meteorology, oceanography, archaeology, medicine, and environmental sciences.

Some IRM acquisitions cover general-purpose resources, while others support embedded systems in space and other scientific systems. Most of the acquisitions are mission specific. Therefore, the vendor, to be successful, must understand the mission objectives of the procurement and be prepared to connect a proposal to it.

3. Information Systems/Acquisition Planning Program

Despite its largely decentralized management and program structure, NASA has implemented and enforces a uniform series of policies on planning. Standard Information Systems Planning (ISP), which supports the budget process, originates at each Center and conforms to standard content and scheduling. Acquisition planning, which supports NASA's procurement process, originates at the proponent program office and also conforms to standard content requirements.

a. Information Systems Planning (ISP)

NASA's ISP program is governed largely by Headquarters Directive NHB 2410.ID, dated April, 1985. The ISP process begins at each Center, with the development of an Information Technology Systems Plan. These plans are not, for the most part, available to the public. In fact, except in rare circumstances, planning personnel from one Center may not review the plans from other Centers. However, NASA's Inter-Center Committee, containing representatives from each Center as well as headquarters personnel, provides mutual assistance in the planning process.

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The OMB budget process governs NASA's planning schedule. Exhibit III-4 provides both the traditional and most recent schedule for planning activities at NASA.

EXHIBIT III-4

NASA PLANNING SCHEDULE

Activity	Traditional Date	Recent Date
HQ Planning Call to Centers	June 1	March 1
Center Plans to HQ	Sept. 15	June 15
Program Office Review	Oct. 15	July 15
IRM Review	Nov. 15	August 15
Comptroller Review, Submit to OMB	Dec. 15	Sept. 15
Budget Mark Received	Feb. 15	

This year, NASA HQ expedited the process by ninety days. This speed-up grew out of a requirement from OMB. There are two types of plans at NASA:

- Program Operating Plans focus on specific programs, such as the Space Station; and
- Institute Operating Plans focus on specific institutions such as the HQ Computer center.

This year, OMB requested that the Space Flight Program Operating Plan be submitted in May. By expediting the remaining plans by ninety days, NASA brought the process more into line. At this writing, it is not clear if NASA will return to the traditional planning schedule. Unlike some agencies, NASA does not update its plans at midyear following receipt of the budget mark from OMB. Rather, NASA simply waits until the next planning process begins.

NASA's annual Information Technology Systems Plan describes the overall planning effort associated with the application of information processing resources to agency activities. Exhibit III-5 summarizes the minimum required contents of each center's plan:

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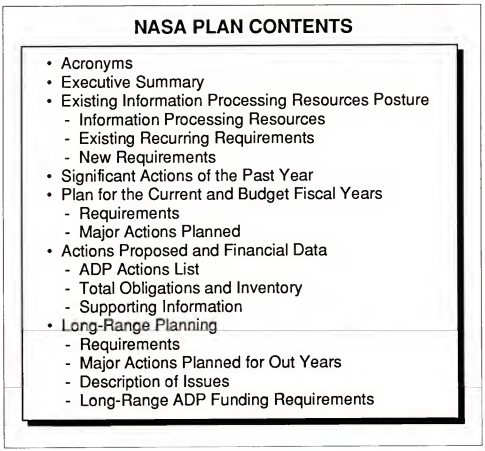
EXHIBIT III-5


NASA PLAN CONTENTS
• Acronyms
• Executive Summary
• Existing Information Processing Resources Posture
- Information Processing Resources
- Existing Recurring Requirements
- New Requirements
• Significant Actions of the Past Year
• Plan for the Current and Budget Fiscal Years
- Requirements
- Major Actions Planned
• Actions Proposed and Financial Data
- ADP Actions List
- Total Obligations and Inventory
- Supporting Information
• Long-Range Planning
- Requirements
- Major Actions Planned for Out Years
- Description of Issues
- Long-Range ADP Funding Requirements

This plan format includes typical OMB A-11 data, including the contents of both the A-11 43A and 43B exhibits. Following review and occasional modification by the HQ program oversight office, the Comptroller's office combines the material into an agency wide plan. HQ Information Systems personnel also assemble a plan, just as the centers do. This also gets folded into the agency wide plan.

b. Acquisition and Planning

NASA also uses NHB 2410.ID to dictate policy on acquisition planning. At certain thresholds, NASA requires detailed plans in order to ensure that:

- Proper planning for the acquisition action has taken place,
- Requirements leading to the acquisition have been reviewed and validated, and
- Compliance with all applicable directives has been accomplished.

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NASA's extensive acquisition planning requirements may represent an important marketing opportunity, particularly for small firms located near each center. Those unable to bid on the acquisition itself may assist NASA in developing the planning documentation. Since most buys originate at the centers, the planning documentation is also developed there.

Under certain circumstances the Associate Administrator for Management receives a copy of the acquisition plan. Exhibit III-6 itemizes some of these circumstances. In some cases, approval must be obtained, while in other cases the center need only provide an information copy.

EXHIBIT III-6

INVOLVEMENT BY ASSOCIATE ADMINISTRATOR FOR MANAGEMENT

	Equipment	Software	Services
Approval	• Purchase Price Exceeds $1,000,000 • Annual Rental Exceeds $300,000	—	—
Information Copy	• Sole Source Exceeds $250,000 • Annual Rental Exceeds $100,000	• Competitive Exceeds $1,000,000 • Sole Source Exceeds $100,000 • FIPS Waiver Required	• Competitive Exceeds $2,000,000 • Sole Source Exceeds $300,000

At a minimum, equipment acquisition plans must contain the following elements:

- Analysis of Requirements
- Analysis of Technical Alternatives
- Comparative Cost Analysis
- System Description
- Funding Data
- Schedules
- Acquisition Method
- Security and Privacy Safeguard

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- Future Competition
- Long-Range Requirements
- Annual Information Technology Systems Plan Cross-Reference
- Software Conversion Study (when required)
- Federal Information Processing Standards (FIPS) Waivers (when required)

Although acquisition plans for software and services differ slightly in format, they mainly contain the same elements.

This uniformity of planning, both for the annual cycle as well as for specific acquisitions, represents a key area of commonality among the centers and across the agency. The decentralized nature of NASA programs can lead to potential miscommunications between centers and program managers. This in turn can lead to inefficiencies in multicenter programs, such as the Technical Management Information System (TMIS). However, the planning guidelines serve to strengthen intercenter ties and thus reduce disconnects.

B

Information Systems Structure and Functions

As pointed out in Section A, NASA operates primarily with a decentralized management and program structure. Most ISP originates at the centers and in support of specific programmatic activities. The program drives the decision, and ISP follows that decision. However, since the centers have different functions, they organize their offices in general—and their information systems offices in particular—in widely different fashions. A comparison of two centers, Lewis and Goddard, illustrates this point.

At the Lewis Research Center, the Computer Sciences Division houses most of the typical information systems functions. It contains the following branches:

- User Services,
- Scientific Services,
- Experimental Data Applications,
- Management Information Systems,
- Special Projects,
- Maintenance and Operations,
- Micro/Mini Computer Systems,
- Mainframe Systems, and
- Telecommunications and Networking.

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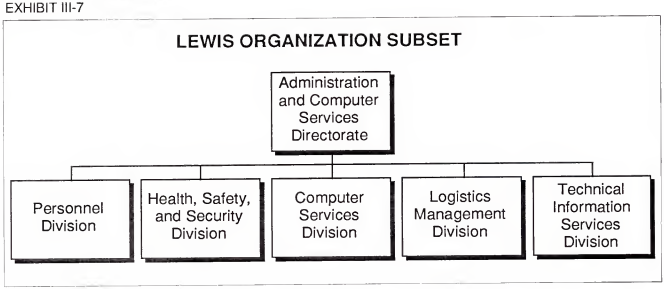
The Chief, Computer Services Division, reports to the Director, Administration and Computer Services Directorate. However, as shown in Exhibit III-7, several apparently unrelated divisions belong to the same directorate.

EXHIBIT III-7



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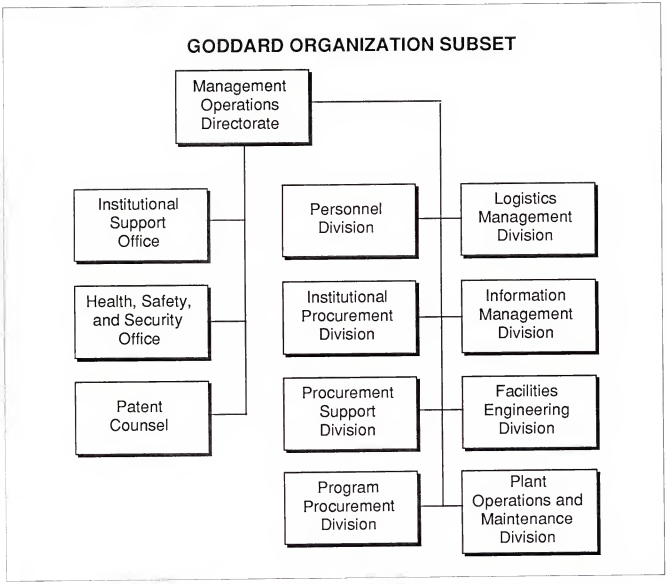
Goddard Space Flight Center uses a somewhat different approach. It contains two information systems organizations supporting different functions. The Management Operations Directorate contains the Information Management Division. It supports mainly the administrative data processing activities at Goddard. Just as is the case at Lewis, the administration directorate at Goddard oversees a wide variety of functions (Exhibit III-8).

EXHIBIT III-8



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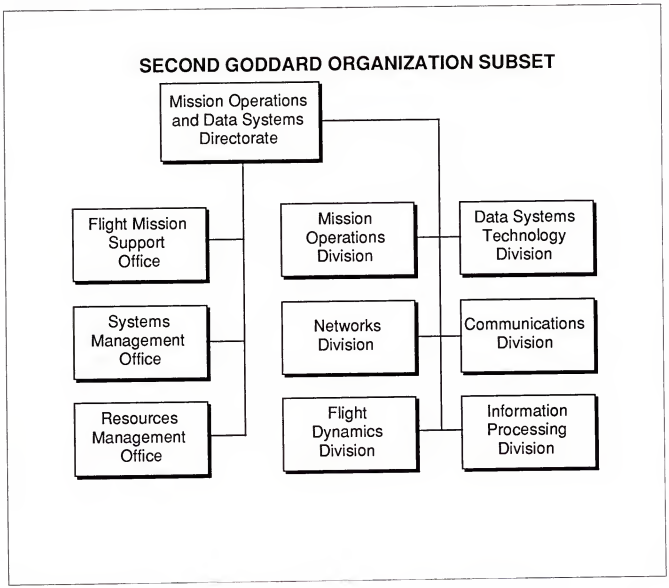
However, much of Goddard's data processing activities are housed in a separate organization, the Mission Operations and Data Systems Directorate. This directorate provides data processing support to mission-oriented Center programs. Exhibit III-9 shows the office and division breakout for this directorate. In this case, typical IRM functions are scattered across multiple divisions.

EXHIBIT III-9



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NASA headquarters functions focus primarily on the five key program administrators, as shown earlier in this section. Each of the five program codes— E, R, M, S, and T—has its own IRM or similar function. The individuals in these positions oversee information systems functions at their subordinate centers.

In addition, NASA headquarters contains three other key offices. The Assistant Associate Administrator for Information Resource Management (Code NT) performs headquarters oversight for all NASA IRM activities. This oversight includes such typical functions as software management, planning, and security, as well as such atypical functions as supercomputing management and records management.

Next, NASA has a headquarters computer operations function that operates in a manner similar to a center office. The Information Technology Division, Code DT, supports headquarters as if it were another center. This code was created in the spring of 1988, as a result of a reorganization. Finally, the Inspector General's office, Code W, has taken on an active role in reviewing agency programs. The Assistant Inspector General for Management works closely with headquarters program offices in the review of major information system initiatives.

In terms of acquisition initiatives, the Office of Procurement (Code H) plays a major role. In particular, the Procurement Policy Division (Code HP) submits the Agency Procurement Request (APR) to GSA. This differs from most major departments, in which the central IRM office handles the APRs. Following the delegation, the procurement usually goes back to the initiating center for execution.

C Information System Trends

Despite its decentralized mode of operation, NASA has taken some steps to bind programs together. Some respondents, at both headquarters and field sites, expressed the need for better information access. NASA is a long way from the vertical and horizontal integration of information, wherein any authorized user can access any information from any terminal. Many agencies have identified this as a goal. Although this higher level of integration may not be appropriate for NASA, some movement to centralized systems is clearly taking place.

NASA's Intercenter Committee on ADP, composed of representatives from headquarters and from each center, meets periodically to share data on information systems activities. Each member reviews the activities at the other centers, and then uses these approaches and systems whenever possible.

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The Automated Information Management (AIM) Program supports the overall NASA objective of improving the delivery of administrative and management support ADP services. It will provide a mechanism for the identification, evaluation, development, and implementation of agency wide applications. NASA also expects the AIM applications to improve agency productivity. Section V discusses the AIM Program in more detail.

In interviews with headquarters executives, INPUT frequently heard of the importance of the Software Support Environment (SSE). Strictly speaking, the SSE will support NASA's overall software architecture for the Space Station Program (SSP). However, several executives now view SSE's usefulness as extending beyond the SSP. The SSE can provide a framework for most major software initiatives in the 1990s. Since several centers are producing software for the SSP, the architecture will fit naturally for many of their systems. NASA headquarters executives hope this program will extend to the remaining centers. This is in keeping with the overall trend toward somewhat less decentralization. Section V contains more specific information on the SSE.

The Program Support Communications Network (PSCN), initiated in April 1985, further supports information sharing at NASA. It consolidates intra-agency programmatic and administrative applications, allowing the elimination of several hundred dedicated and point-to-point circuits between centers. This has led to both operating efficiencies and cost benefits through user sharing of transmission trunks and switching equipment. Section V contains more specific information on the PSCN.

Other information system trends at NASA relate to its use of state-of-the-art computer technology. Despite NASA's high-tech image, the GAO concluded last year that, in some respects, NASA's use of technology had fallen 5 to 15 years behind in computer science and machine intelligence. In response to this apparent problem, NASA has initiated wide-ranging efforts in artificial intelligence, leading to a growth in its robotics technology development program. This activity is expected to pay off when implementing the Space Station Program (SSP).

NASA has identified three objectives in its use of automation and robotics for the SSP:

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- Reduce the cost of mission control (both ground support and astronaut time spent in housekeeping functions);
- Increase the operational capability of the astronauts by giving them the tools to enable the assembly, servicing, and repair of spacecraft distant from their base vehicle; and
- Increase the probability of mission success.

This illustrates another key trend in information systems at NASA—the technology follows the program. There is little interest in researching artificial intelligence (AI), for its own sake. Rather, AI's ability to influence mission success represents the primary concern.

Various bodies, including NASA's Advanced Technology Advisory Committee (ATAC) and Congress' Office of Technology Assessment (OTA) have expressed concerns about the development and implementation of automation and high-quality software. For example, some NASA executives doubt that the SSE will be ready for the initial Space Station design stages. The concern extends to another SSP system, the Technical and Management Information System (TMIS), which is described in Chapter V. TMIS costs could be higher than expected if the system uses off-the-shelf packages that have not been converted to the target language.

In supporting its primary programs, NASA faces a typical quandary. On the one hand, if it uses proven off-the-shelf systems in designing automation support, these systems will likely become obsolete by the time the program comes on line. On the other hand, if it uses state-of-the-art techniques in designing its information systems, it faces potential schedule delays and cost overruns in critical components. NASA information systems executives need to finesse these competing forces and reach the best available compromise. Similarly, vendors wishing to support NASA programs must bid systems and approaches that take advantage of the latest technology and avoid or minimize the associated risk.

As already discussed above, some concern has been voiced over NASA's use of technology. In the fall of 1987, the National Research Council, an operating agency of the National Academies of Sciences and Engineering, issued a report entitled *Space Technology to Meet Future Needs*. The report criticizes NASA's efforts in developing basic new technologies that will enable future missions to provide the nation with a variety of options for the space program. It recommends that basic research and

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development be given a higher priority and guaranteed a sufficient budget. This seems highly unlikely, however, given NASA's highly volatile budget environment.

The report goes on to say that many basic research programs have been terminated or "allowed to wither" before the technologies were ready for use. It also calls for a return to research on an array of new space technologies. For example, even the shuttle was built largely with existing technologies. The space shuttle main engine is the only significant development in space propulsion in the past 20 years. NASA has indicated that it will look carefully at all new technologies before committing significant funding to them.

A later section of this report, the Market Forecast, provides additional discussion on information system trends at NASA.

D Procurement Trends

NASA's procurements for contracts, grants, agreements and other types of procurement of $25,000 and over during Fiscal Year 1987 totalled $8,609.8 million. This is 5.3 percent more than was awarded during Fiscal Year 1986.

It is estimated that 10% of the FY 1987 procurements were for the acquisition of information technology and services. IT procurements are generally among the largest in dollar value and are procurements that originate at the field installations.

For Fiscal Year 1987 the distribution of NASA's procurement obligations is shown in Exhibit III-10. Awards to business firms accounted for 76 percent of the total obligations. These awards totalled $6,540.5 million, which is $184.5 million or 2.9 percent more than in Fiscal Year 1986. Most of the awards to business firms were for large continuing research and development contracts for major systems and major items of hardware. Small business firms received $786.3 million of NASA's direct awards to business firms.

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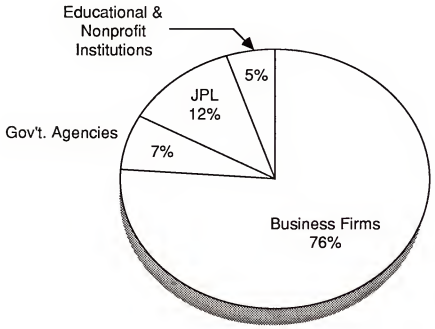
EXHIBIT III-10

NASA AWARDS BY TYPE OF CONTRACTOR FISCAL YEAR 1987



Type Contractor	$ Millions
Business Firms	6,540.5
Educational Institutions	315.4
Nonprofit Organizations	119.1
JPL	1,005.6
Government Agencies	594.9
Outside United States	34.3
Total	8,609.8

Source: Annual Procurement Report, Fiscal Year 1987, National Aeronautics and Space Administration HDQ, Office of Procurement.

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The majority of NASA's purchases and contracts are made by the procurement offices of its field installations. During Fiscal Year 1987, these offices accounted for 94 percent of the total procurement dollars, as shown in Exhibit III-11.

EXHIBIT III-11

FY 1987 PROCUREMENTS BY NASA INSTALLATIONS

Installation	Award (Millions)	Percent
Marshall Space Flight Center	$2,059.7	23.9
Johnson Space Center	1,627.4	18.9
Goddard Space Flight Center	1,313.3	15.3
NASA Resident Office/JPL	1,008.8	11.7
Kennedy Space Center	883.4	10.3
Headquarters	507.5 *	5.9
Ames Research Center	467.0	5.4
Lewis Research Center	381.8	4.4
Langley Research Center	289.5	3.4
Stennis Space Center	71.4	0.8
TOTAL	8,609.8	100.0

* Includes $148.2 million in reimbursable funds to U.S. Treasury for TDRSS.

Source: Annual Procurement Report, Fiscal Year 1987, National Aeronautics and Space Administration HDQ, Office of Procurement.

With respect to contract types, awards on contracts having cost-plus-award-fee clauses amounted to 52 percent of the total awards of $25,000 and over to business firms. Incentive contracts, both cost-plus-incentive-fee and fixed-price-incentive, accounted for 22 percent of total awards. Awards on firm-fixed-price contracts constituted 13 percent of the total. Cost-plus-fixed-fee contracts accounted for 11 percent of the total (Exhibit III-12).

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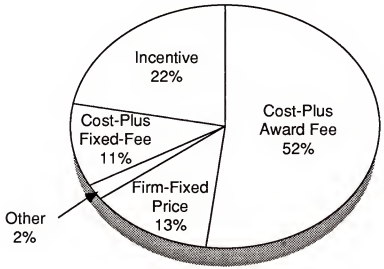
EXHIBIT III-12

AWARD BY CONTRACT TYPE
DIRECT AWARDS TO BUSINESS FIRMS FISCAL YEAR 1987



Contract Type	$ Millions
• Firm-Fixed-Price	849.7
• Incentive	1,425.7
- Fixed-Price-Incentive	204.2
- Cost-Plus-Incentive-Fee	1,221.5
• Cost-Plus-Award-Fee	3,294.1
• Cost-Plus-Fixed-Fee	696.1
• Other	111.2
- Fixed-Price-Redetermination	-
- Economic Price Adjustment	7.0
- Cost-No-Fee	69.1
- Cost-Sharing	28.6
- Labor-Hour	.8
- Time and Material	5.7
• Total	6,376.8

Note: Includes Awards of $25,000 and Over Only.

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The large percentage of procurements that have award fee and incentive provisions resulted from major procurements for the Space Shuttle program. The increase in the percentage of award fee dollars in Fiscal Year 1987 is primarily because of restructuring contracts associated with the Space Transportation System program as a result of the Challenger accident.

INPUT's recent discussions with NASA's procurement and planning officials show no clear trend in preferences. Rather, if a program or project is well defined, NASA prefers a fixed-price approach. Otherwise, the cost-plus approach is preferred.

NASA is in the process of changing its procurement rules in the FAR supplement to amend the procedures for unsolicited proposals. In an effort to promote the submission of unsolicited proposals relevant to the agency's mission, the agency's Office of Procurement will prepare a brochure for public use and will also appoint an unsolicited proposal coordinating office at each NASA field site and at NASA headquarters. The unsolicited proposals will not be considered for formal evaluation unless the offerer has given its express consent.

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NASA Market Forecast

A

Past and Current Funding Patterns

In determining future information technology funding, it is useful to examine past funding patterns. Exhibit IV-1, provided to INPUT by NASA, shows total agency and information funding for the past 17 years. As is apparent, the information technology curve grows more steeply than the overall budget curve. This indicates that information technology has taken a steadily larger portion of the agency budget. Within information technology, the "Other" category, consisting largely of various kinds of services, represents the biggest portion.

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EXHIBIT IV-1

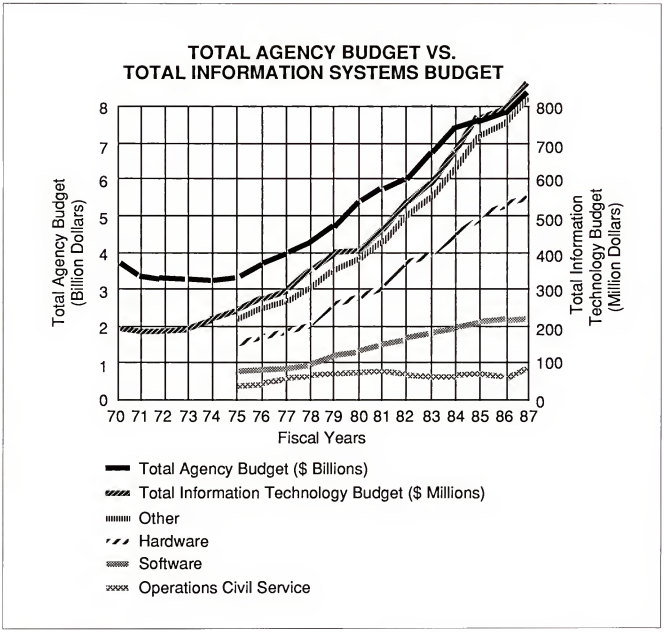

Exhibit IV-2, also provided by NASA, supports this finding. In FY 87, slightly more than half of NASA's information technology budget went to services. Although NASA categorizes things somewhat differently than INPUT, the percentages shown represent a useful perspective on NASA's budget. INPUT's overall forecast, shown in Section II, shows a somewhat larger budget base for FY 88 than this exhibit shows for FY 87. This comes from the fact that the overall agency budget has sharply increased, with information technology taking a bigger portion.

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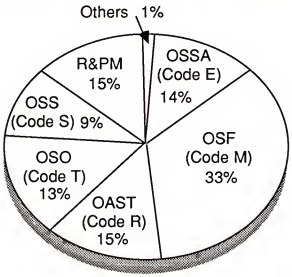
EXHIBIT IV-2

NASA INFORMATION TECHNOLOGY FUNDING DISTRIBUTION FY 1987 TOTAL OBLIGATIONS $818 MILLION

FUNDING BY PROGRAM OFFICES



FUNDING BY MAJOR FUNCTIONAL AREAS

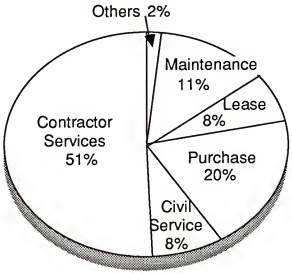


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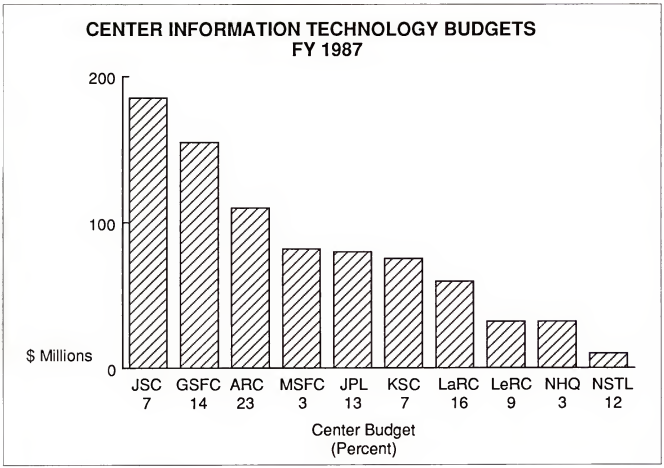
Exhibit IV-3, again provided by NASA, shows the spending distribution among headquarters and the various centers. As is apparent, Johnson and Goddard consume the largest portions of NASA's overall information technology budget, although the spending at Johnson represents only 7% of its overall budget. With Johnson managing the Space Station Program, INPUT expects its portion of the information technology budget to rise sharply.

EXHIBIT IV-3



B

Market Segment Forecasts

Based on NASA's A-11 budget submissions, individual center plans, and interviews, INPUT has developed segment forecasts for NASA. This section covers those segments.

1. Facilities Management

Exhibit IV-4 shows that the NASA facilities management market will grow from $131.5 million in 1988 to $200 million in 1993. This represents an AAGR of 9%. In this case, both the Contractor Owned, Contractor Operated (COCO) portion and the Government Owned, Contrac-

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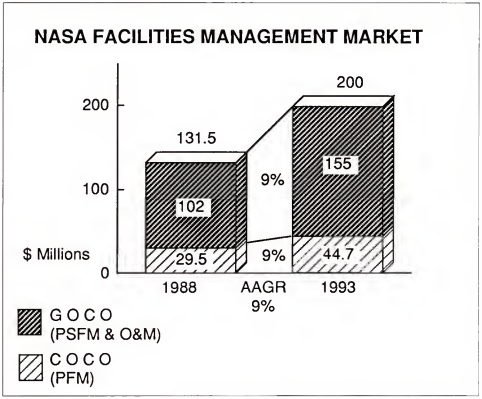
tor Operated (GOCO) portion will grow at the identical 9%. However, COCO represents less than one quarter of the total market. GOCO includes Professional Services Facilities Management (PSFM) and Operations and Maintenance (O&M). COCO includes Processing Facilities Management (PFM).

EXHIBIT IV-4



2. Telecommunications

Exhibit IV-5 shows that the NASA telecommunications market will grow from $69.2 million in 1988 to $99.3 million in 1993. This represents an AAGR of 7%, which coincides directly with INPUT's forecast for the government as a whole. However, if the planned growth of inter-center resource sharing is actually enacted, this growth rate will likely increase sharply. The telecommunications market includes professional services, hardware, and leased telecommunications (both networks and transmission facilities).

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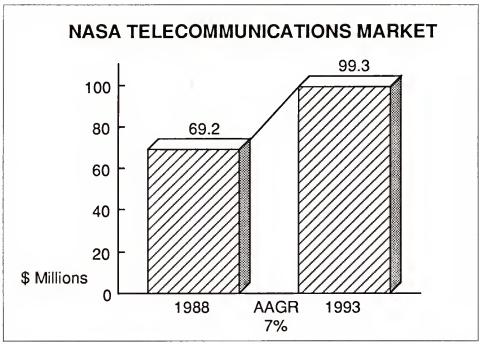
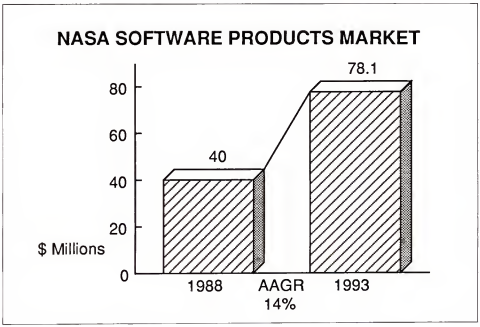
EXHIBIT IV-5



3. Software Products

Exhibit IV-6 shows that the NASA software products market will grow from $40 million in 1988 to $78.1 million in 1993. This represents an AAGR of 14%, which slightly trails INPUT's overall government forecast of 16% in this segment. NASA's 43A submissions for the last few years provided the key source for this forecast, and these numbers have lagged behind governmentwide growth.

EXHIBIT IV-6



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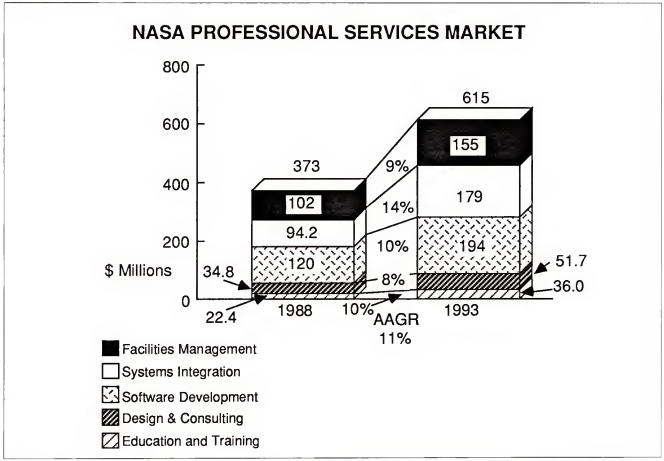
4. Professional Services

Exhibit IV-7 shows that the NASA professional services market will grow from $373 million in 1988 to $615 million in 1993. This represents an AAGR of 11%, somewhat less than the 13% growth rate that INPUT predicts for the government as a whole. This lower growth rate stems largely from NASA's relatively larger starting base. However, NASA's growth in the facilities management portion of professional services, as well as education and training, is larger than the overall government growth. However, the other three categories show lower growth at NASA, and this brings down the overall average.

EXHIBIT IV-7



5. Processing Services

Exhibit IV-8 shows that the NASA processing services market will grow from $42.2 million in 1988 to $62.6 million in 1993. This represents an AAGR of 8%, which matches INPUT's forecast for the government as a

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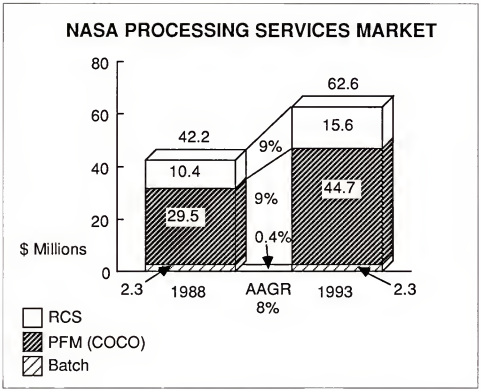
EXHIBIT IV-8



whole. However, the components differed. Although INPUT showed no growth in federal batch processing, NASA shows slight growth. However, with the rounding, both 1988 and 1993 show identical totals of $2.3 million.

6. Office Information Systems

Exhibit IV-9 shows that the NASA office information systems market will grow from $70.7 million in 1988 to $108 million in 1993. This represents an AAGR of 9%, which lags behind INPUT's total federal forecast of 11%. The biggest gap occurs in the professional services portion of office systems, which is 16% overall, but only 12% at NASA.

7. Systems Integration

Exhibit IV-10 shows that the NASA systems integration market will grow from $185 million in 1988 to $349 million in 1993. This represents an AAGR of 14%, again lagging behind the 16% overall government rate. Just as in other segments, the professional service portion of NASA system integration was lower than that for the government as a whole, 14% to 17%.

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EXHIBIT IV-9

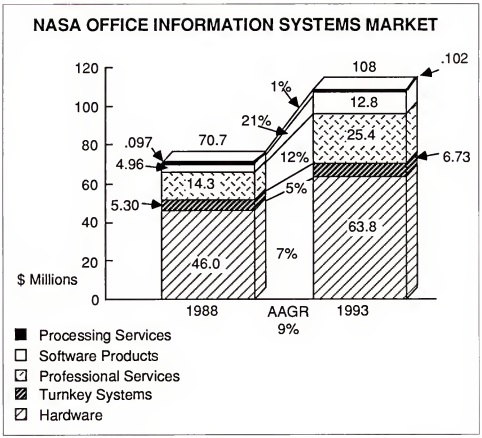
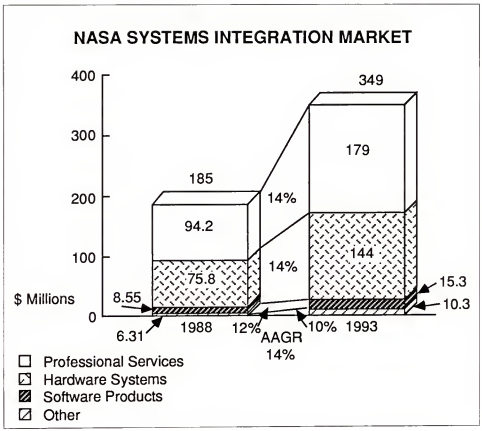


EXHIBIT IV-10



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Major Information System Acquisition Plans

As might be expected in any decentralized organization, NASA has identified a wide variety of information system acquisitions. Some of these will help to bring information processes together. The AIM program, for example, which is discussed in an earlier section, will enhance information sharing. However, most systems remain relatively independent and self-contained. This section discusses some of the key strategies.

A Space Station

The Space Station Program (SSP) is the dominant NASA initiative of the 1990s. Since the information systems follow the programs, it is to be expected that the systems supporting the SSP will dominate. This section discusses some of the major SSP information systems.

NASA intends to solicit bids for construction of a privately owned industrial space station, a large part of which the government would then lease. NASA has estimated a contract value of $140 million per year. Various agencies would take five-year leases on the automated facility for a total of $70 million.

Meanwhile, NASA's budget for its larger and more sophisticated manned space station is estimated at $16 billion. National security considerations will directly affect dissemination of space station data. The Pentagon may exercise some veto power. A related directive supports "the public, nondiscriminatory direct readout of data from federal civil systems to foreign ground stations" with the provision that this data would be furnished under an as-yet-unformulated "specified condition."

NASA intends to use advanced automation, robotics, and high-quality software in achieving program effectiveness and controlling life cycle

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costs. Automation is expected to improve ground and in-orbit operations. Automation will:

- Increase the system's ability to support innovation
- Allow the Space Station to operate autonomously
- Perform tasks unsuited for humans
- Reduce hazards to human life
- Increase crew productivity, and
- Lower operating costs.

Robotics will reduce risks to humans by performing hazardous tasks associated with space flight. High-quality software will help to control maintenance costs and also will facilitate the eventual transfer of ground-based functions to the station.

1. Space Station Information System (SSIS)

The SSIS will provide information management throughout the life of the Space Station. The SSIS will provide systems control and data management on board the Space Station, as well as communications to and from the ground, to all ground-based mission operations, and world-wide distributed processing of data for station users. It will provide support in three areas:

- Prelaunch checkout, mission management, scheduling, and control
- Software development, and
- The acquisition, transmission, recording, processing, accounting, storage, and distribution of data.

When agency executives are asked about the SSIS, they invariably mention the Software Support Environment. This is the first module of the SSIS.

The Software Support Environment (SSE) is the collection of software, procedures, standards, hardware specifications, documentation, policy, and training materials that, when implemented in hardware and computer network(s), provides the environment used by the Space Station program for life cycle development and management of software.

SSE will provide a set of methods, tools, standards, and Data Management System (DMS) software that is to be designed for operation on a

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specified number of computer families. The use of the SSE has been mandated for all flight and ground software that is under configuration control in the Space Station Program.

The software, procedures, standards, hardware specifications, documentation, policies, and training materials will be supplied to the SSE contractor as government-furnished equipment (GFE). Agency executives hope to leverage the SSE into most other major NASA programs in the 1990s.

2. Technical and Management Information System (TMIS)

NASA is currently implementing a Technical and Management Information System (TMIS) for the purpose of providing the necessary collection, dissemination, and processing of data to manage the Space Station Program. The system will establish a communications network and data base to link together the NASA center, their contractors, and international partners. TMIS will be a planning and managerial tool for the Space Station Definition and Preliminary Design Program, which will be incrementally upgraded over the ten-year contract life.

TMIS will provide all computational resources needed to fulfill the requirements for the development of the Space Station Definition and Preliminary Design Program. In addition, TMIS will establish the technical data base and the common user data management system required for the Space Station Program. TMIS will serve as a distribution vehicle that will assist in the technical and programmatic coordination among the Space Centers working on the development of the space station.

The planned capabilities of the system include:

- The capability to exchange technical and management information (for example, drawings and budgets) between all Space Station participants, including NASA centers and contractor locations;

- Sixteen data processing capabilities (for example, word processing and computer-aided design) in support of 28 program functions—such as project management, technical analysis, and Space Station operations; and

- The capability to archive and store program information throughout the station's operational life.

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The TMIS contract was awarded to Boeing Computer Services in June, 1987.

The Contracting Office indicated that the value of the first increment of TMIS is approximately $89.7 million, spread among various market segments. However, the contract will have a value of approximately $331 million over several years.

Choosing and integrating TMIS software with the SSE may pose a major technical challenge. It is expected that TMIS will be built primarily with software packages, many of which are in COBOL or FORTRAN. However, many other elements of the Software Support Environment (SSE) will likely include Ada code. This may lead to some interface problems.

3. Customer Data and Operation System (CDOS)

NASA has established the Customer Data and Operations System (CDOS) to adjust the NASA practice of supporting customers in launch activities, including communications with the Space Station and control centers. Although CDOS is not part of the Space Station proper, it is allied with the Space Station.

As such, CDOS has a schedule consistent with Space Station needs and its budget is currently linked to the Space Station.

Funding for this program provides for the definition, design, installation, and maintenance of the control center for the Space Station platforms (Polar and Co-Orbiting). The System provides general communications from the White Sands Missile Range to the entire Space Station communications network, plus some of the return communications.

The objective of the CDOS program is two-fold: first, to improve transmission of and accessibility to scientific data from experimental payloads; and second, to allow scientists to control a payload within certain limitations as if it were in the laboratory.

According to the CDOS Program Office, the preliminary design would be worth $2-4 million per contract, and the full implementation would be worth $200-400 million. The program was awarded in 1987 to Bendix, as a ten-year operations support contract. An RFP for Phase B was expected to be released in June 1988.

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B

Space Transportation System (STS)

After the Space Station, agency executives most frequently mention specific elements of the STS. NASA developed the STS to reduce the cost of space operations and provide easy access to space for commercial enterprises, foreign governments, the Department of Defense, and other government agencies. Exhibit V-1, taken from a GAO report, summarizes the major STS programs. GAO estimated that STS would contain 25 million lines of software code, written in at least six languages. So again NASA must deal with the problem of interfacing systems in multiple languages.

The Associate Administrator for Space Flight, Code M, exercises overall management responsibility for the STS. Although all four centers reporting to Code M (Johnson, Kennedy, Marshall, and Stennis) are supporting the STS, Johnson is clearly taking the lead.

1. Flight Planning

Flight Planning operations support scheduling for crew and mission activities, as well as produce the necessary trajectories. Included are:

- The flight design system, which is used to analyze each mission's flight plan;
- The crew activity planning system, which develops, analyzes, and schedules all activities that the orbiter crew will perform in flight; and
- A planning system for the remote manipulator system, which is used to plan and evaluate the operation of the orbiter's remote manipulator system, a 50-foot-long mechanical arm mounted in the orbiter's cargo bay, and is used in such space operations as satellite retrieval.

Exhibit V-1 shows that these systems are written primarily in FORTRAN, which has historically been the most popular language for scientific applications. However, the wide variety of host hardware systems may still pose obstacles to the integration of information.

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EXHIBIT V-1

SPACE TRANSPORTATION SYSTEM— EQUIPMENT AND SOFTWARE SUPPORTING MISSION OPERATIONS

Mission Operations	Equipment	Software/ Languages Used
Flight Planning		
- Flight Design	- Unisys 1100s - Perkin Elmer - Hewlett-Packard 9000s	- 4.7M Lines of Code - Fortran 66 - Fortran 77
- Crew Activity	- DEC/Vax 11/750s and VS 100s	- 57,000 Lines of Code - Fortran 77 - Fortran V
Flight Readiness		
- S/W Development	- Amdahl 5870 & 800 User Terminals	- 1.3M Lines of Code - PL1, HAL 360, ADF and Assembly Code
- S/W Production	- IBM 3033s - IBM 3084 - AT&T 6300 PC Terminals - IBM SPF Terminals	- 2.3M Lines of Code - PL1, UNIX, and C
- Mission Simulation	- Unisys 1100s - IBM AP101s - Perkin Elmer 832s & 352s	- 1.6M Lines of Code - Fortran V - Assembly Code
Flight Control		
- Launch Processing	- ModComp 11/45s - Honeywell 66/80s - Honeywell DPS 8/70s	- 13M Lines of Code GOAL (Custom Language)
- Mission Control	- IBM 3083s - IBM 3081	- 1.8M Lines of Code - Fortran V - PL1 - Assembly Code
- Shuttle On-Board	- IBM AP101s	- Over 580,000 Lines of Code HAL (Custom Language) - Assembly Code

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2. Flight Readiness

Flight readiness operations include the development of software for each flight, as well as simulation software for each flight. When necessary, flight readiness operations also modify mission control system software.

As shown on the Exhibit, flight readiness operations contains three separate modules:

- The software development system, which modifies and adds new computer logic and equations to enhance shuttle operational capabilities;
- The software production system, which modifies the vehicle, payload, and avionics data that are unique for each mission, and which produces an overall software package for each flight; and
- The mission simulation system, which trains flight and ground crew members in handling both normal and contingency operations at various flight stages, including prelaunch, ascent, in-orbit, descent, landing, and abort.

In the case of flight readiness operations, both the software languages and the host computer environments vary considerably.

3. Flight Control

Flight control operations, ranging from prelaunch to orbit to landing, cover the software for controlling each flight. NASA has targeted the first element of flight control, launch processing, for modernization.

The Kennedy Space Center has initiated the Launch Processing System (LPS) II effort. According to NASA, parts of the present LPS are nearly 17 years old. Modernization of the LPS may also support Space Station activities in the 1990s.

The Checkout, Control, and Monitor Subsystem (CCMS) forms a major component of LPS II. The CCMS contains the following elements:

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- Operator-manned consoles in the firing room,
- Minicomputer,
- A data recording area,
- Hardware interface modules,
- A common data buffer, and
- Front end processors.

The other elements of flight control operations include:

- The mission control system, which performs real-time command and control of shuttle flights from launch through landing and crew egress, as well as other nonflight activities, including flight simulations, launch pad tests, communications network tests, and software testing and validations; and

- The shuttle on-board system, which controls and monitors almost every phase of shuttle operations, from vehicle testing at the orbiter manufacturer's plant through ascent, orbit, re-entry, and landing.

In this last case, NASA uses five computers to control the orbiter's avionics (aeronautic and electronic systems). Given the obvious importance of this system, NASA uses four of these computers redundantly, with each running the avionics software independently and simultaneously. These computer majority vote the computations. If one computer differs from the others, the mission commander may deactivate it. The avionics software flies and controls the orbiters, providing guidance, navigation, and control during each flight phase, and during contingency phases such as abort. The fifth computer runs the backup software. It can provide guidance, navigation, and control during ascent, orbit, re-entry, landing, or even abort, should the primary avionics fail.

C
Major Information Systems Initiatives

In addition to the initiatives already described, NASA has numerous other significant activities aimed at modernizing its information technology activities and better supporting its mission. NASA's most recent OMB A-11, 43B submission, published in March, 1988, contains more than a thousand distinct initiatives. In preparing this report, INPUT totaled the acquisition plans for two of NASA's smaller centers, Lewis and Ames. Exhibit V-2 summarizes the results of this analysis. Although no clear pattern emerges, it is obvious that, at least at these two centers, NASA will make growing use of professional services to support its mission. Section VI contains more information on agency buying plans, and Section VIII contains specific marketing opportunities that INPUT has researched and identified.

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EXHIBIT V-2

SUMMARY—NASA OMB A11-43B—SELECTED CENTERS: LEWIS & AMES

	Hardware ($ Million)					
	FY88	89	90	91	92	93
Lewis	16.5	19.3	19.7	18.6	16.2	16.6
Ames	41.5	35.5	37.3	36.6	42.5	41.9
	Software ($ Million)					
	FY88	89	90	91	92	93
Lewis	4.1	3.9	4.3	4.7	5.1	5.9
Ames	3.2	3.0	2.9	3.2	3.3	3.4
	Services ($ Million)					
	FY88	89	90	91	92	93
Lewis	11.8	13.7	15.4	16.9	18.9	20.7
Ames	39.7	44.4	36.6	37.2	40.9	43.3

1. Procurement Management Technology Program (PMTP)

NASA Headquarters is managing the PMTP, an agency wide standard automated procurement system. It is intended to:

- Increase procurement productivity;
- Improve the quality of procurement documents;
- Decrease procurement lead times;
- Furnish accurate, on-line management information; and
- Improve customer support.

The PMTP contains three major subsystems, which are being developed incrementally;

- The Acquisition Management Subsystem, which provides management reporting, tracking, and forecasting of procurement request actions, contract deliverables, and contract administration activities;

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- The Document Management Subsystem, which provides on-line generation of RFPs, IFBs, and resulting contracts; and

- The Procurement Regulation Subsystem, which provides an automated access and search capability to the principal procurement regulations, including the FAR, the NASA FAR Supplement, and the NASA Grant and Cooperative Agreement Handbook.

According to NASA's most recent 43B submission, the PMTP is funded as follows:

Fiscal Year	88	89	90	91	92	93
$ Thousands	1743	1849	1561	1511	2008	1504

2. NASA Uniform Personnel/Payroll System (NPPS)

The NPPS will replace 14 nonstandard, installation-unique systems as well as the agency wide Personnel Management Information Systems at headquarters. NASA, in implementing the NPPS, is supporting the Administration's Reform '88 initiative to improve the effectiveness of all federal administrative systems.

Through implementation of the NPPS, NASA expects to:

- Reduce operating costs by automating functions currently performed manually;

- Reduce software maintenance and new development costs by maintaining a single, standard Personnel/Payroll system; and

- Improve service to employees, operating organizations, and management through standardization of systems.

The latest 43B Submission requested the following NPPS funding:

Fiscal Year	88	89	90	91	92	93
$ Thousands	2500	2200	2800	1300	1300	1300

3. Computer Network System (CNS)

The CNS, a subsystem of the Program Support Communications Network (PSCN), will provide NASA with the capability to interconnect its large data centers. The CNS provides yet another example of NASA's

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gradual migration away from independent decentralized information systems. Although INPUT would not characterize the various initiatives as a centralization of activities, the initiatives do represent a step in that direction.

CNS will allow NASA centers to share supercomputer capabilities. This will lead to an improvement in the effectiveness and productivity of the computational effort in support of the aeronautics research and technology program. CNS connects five major NASA computer centers through high-speed digital links.

The PSCN, overall, will provide an all-digital backbone link serving 16 NASA operations centers nationwide. Centralized switching takes place at the Telecommunications Systems Status Center at Marshall. High-speed trunk lines provide connectivity among NASA locations. Off-net users access the system through a U.S. Sprint-Telenet public data network and through direct-dial access. In 1985, Boeing, as the prime contractor, won the $220 million contract.

4. Automated Information Management (AIM)

The AIM Program will improve the delivery of administrative and management support ADP services by providing a mechanism for the identification, evaluation, development, and implementation of agency wide applications. NASA has identified four objectives for AIM:

- Define NASA's long-term needs in terms of automated institutional support;
- Develop the capabilities required to support NASA's future institutional needs;
- Improve the accessibility, accuracy, availability, security, and timeliness of information; and
- Establish a standard hardware and software environment.

The current budget request for AIM funding includes:

Fiscal Year	88	89	90	91	92	93
$ Thousands	700	570	600	650	650	700

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This last objective may exert considerable influence on future administrative procurements. The AIM program provides the structure and management oversight for the development of agency wide standard administrative ADP systems. AIM itself is not a procurement, but rather a discipline for other procurements. For example, NASA is implementing both the NPPS and the PMTP, discussed above, within the AIM program network.

5. Numerical Aerodynamic Simulation (NAS)

Ames Research Center is developing the NAS program to establish and maintain a leading-edge national computation capability. Through the NAS program, NASA intends to ensure leadership in computational fluid dynamics and related disciplines. Through continued state-of-the-art performance, researchers in computational fluid dynamics can address the next level of significant computational problems in the field of aerodynamics research.

Aerodynamics simulation represents one of the key emerging technologies that will strengthen aeronautics research. It will also develop technology toward promoting U.S. leadership in civil and military aviation. NASA is implementing the NAS program in stages. It will be implemented with a standard operating system, UNIX. This is particularly significant to the vendor community, since it takes UNIX out of its traditional small-to-mid-size environment. NAS will include high-speed processors, an integrated support processing complex, graphic workstations, and communications networks. It will be completely interconnected and provide users with a standard operating environment through the NAS Processing System Network. NAS represents yet another example of NASA's move away from self-contained independent systems.

6. Engineering Analysis and Data System (EADS)

Marshall Space Flight Center acquired the EADS to meets it scientific and engineering computational requirements. With its vector processor nucleus, EADS provides ultra-high-speed computing to meet these needs. Specifically, EADS will support the analysis of structural, thermal, control system, fluid dynamics, and optical characteristics of space vehicles and payload.

A Cray supercomputer system supports the EADS. NASA will expand and upgrade the system to support more complex and analytical studies

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for the Shuttle, Spacelab, Spacelab payloads, Space Station, and the Safety, Reliability, Maintainability, and Quality Assurance Program.

7. Kennedy Switched-Data Network (KSDN)

The Kennedy Space Center is implementing the KSDN, a new data-switching capability, as a distributed-node low-speed data switch. Kennedy is installing nodes at major population areas around the center. Each node can support up to 8,000 device addresses. The KSDN provides user connectivity to all major ADP systems and external networks.

NASA intends to support full connectivity, potentially allowing every user device to connect to every other user device. The system is currently scheduled for upgrade.

8. Additional Major Initiatives

In addition to the programs already discussed, NASA has identified several other initiatives that it considers worthy of note:

- The Lewis Information Management System (LIMS), by taking a global view of center requirements and identifying a global solution, will achieve significant cost avoidance. The LIMS will provide office automation capabilities to practically all office workers at Lewis. It will also provide standard interfaces to all central computer resources. LIMS will provide a highly integrated system of automated tools, resulting in long-term productivity increases.

- In addition to the Software Management and Assurance Program initiative, already discussed, individual field center initiatives are improving software quality in specific application areas. For example, Goddard Space Flight Center sponsors the Software Development Conference, a forum for exchanging ideas and experiences on software development strategies and methodologies. For flight projects, a special software assurance review process was formally developed.

- The Jet Propulsion Laboratory (JPL) has initiated several projects to advance scientific knowledge of the planet Earth, the solar system, and the universe beyond. For example, the modernization of the Deep Space Network will provide the data processing capability to handle the higher communications loads necessary to support planned space

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missions into the 1990s. JPL will also provide the capability to support multiple deep-space missions from one operations center. The Space Flight Operations Center (SFOC) will support space flight projects with minimal adaptations required to meet specific mission requirements.

- Goddard has established the Information Resources Oversight Committee (IROC) to ensure top-level management involvement in setting policy and strategic direction for information technology management. The IROC, composed of senior management from each of the directorates, functions as a steering committee for information systems initiatives. The members establish policy procedures, and represent their users' needs in developing strategies and solutions that are consistent with top management's strategic goals and objectives.

- Finally, NASA recently announced plans for a four-satellite Earth Observation System (EOS), to be developed with European and Japanese agencies. EOS will examine complex natural systems with a view toward passing them on to future generations. Goddard has briefed potential vendors on the project. The satellites will be launched in the late 1990s. The first Goddard platform will include such high-tech instruments as a spectrometer, synthetic aperture radar, a geodynamics laser imaging system, and an atmospheric infrared sounder. The EOS could generate as much as a trillion bytes of data per day. As a result, storage and retrieval could account for as much as 25% of the EOS cost.

D
NASA's Use of Technology

Given the highly technical nature of NASA's mission, one would expect a heavy commitment to advanced technology throughout NASA. This is largely the case. Along with Energy and Commerce, NASA is heavily committed to the use of supercomputers. As discussed earlier in this chapter, NASA is now taking steps to share supercomputer technology across centers. For example, the Langley Research Center is seeking to upgrade its supercapacity eight fold. Currently, a Cyber 205 supports Langley's supercomputer needs. Langley will also obtain additional storage devices and software to support research in computerational fluid dynamics, aerothermodynamics, aeroelasticity, and aerothermal levels.

Through its Space and Earth Sciences Computing Center, Goddard is planning the acquisition of a next-generation supercomputer, to be delivered in 1990. It is expected that the new system will provide at least 15 times the power of its current computer.

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Recently, JPL surveyed its scientific community to assess its supercomputer needs. Nearly a third of those responding identified specific supercomputer needs, totaling about 70 hours per week. Apparently, these needs could not be met by other NASA Centers. Furthermore, of the two-thirds who indicated no definite requirement for a supercomputer at JPL, many were using supercomputers at other NASA Centers.

In another supercomputer initiative, Ames recently issued a requirements contract for between 150 and 400 workstations, with associated software, for use with its supercomputers. The new workstations, which will replace VAX computers, will permit access to both the Cray XMP and CDC Cyber 205 systems. Ames considers the workstations to be the core of a major project to define and implement a new interactive computing environment for its users. Ames will purchase both single-user and multiple-user general-purpose workstations. Ames also requires POSIX-compatible operating systems.

The following discussions cover other key technology areas at NASA.

1. Data Management and Storage

NASA's space missions generate a tremendous amount of data and thus pose severe data management concerns. The areas of processing, distribution, and archiving of space science data have caused NASA to allocate much of its computer resources to formulating an environment that supports the operations and research users of information systems.

Data management systems attempt to get the acquired data into accessible and archival mechanisms as quickly as possible. However, this task becomes more difficult as the volume of data generated increases. Future programs such as the space telescope and remote sensing programs for the mid-1990s are estimated to generate as much as a trillion bytes of data per day.

Another example of a future large scientific program that is expected to generate much data is the Earth Observation System (EOS). EOS will be a remote sensing program. In order to estimate the data management requirements for EOS, Goddard Space Flight Center plans to establish an EOS Data and Information Systems Design study by industry vendors and also to complete in-house studies.

INPUT's survey of NASA respondents revealed a growing concern regarding data management and storage technologies. Many offices are

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investigating improvements in end-user tools, more developed graphics, and security requirements for data bases. Optical disk storage is being explored, since much of the data must be stored on-line.

Because of the high volume of scientific data at NASA, the National Academy of Sciences Space Science Board established the Committee on Data Management and Computation (CODMAC). In the 1982 report, CODMAC concluded that:

- There was insufficient involvement of scientists in the data management process,
- Data analysis funds were inadequate and often were reprogrammed due to hardware overruns,
- NASA had not exploited or implemented current data system technologies,
- A responsible scientific group for data management during and/or after missions was not clearly identified, and
- The method NASA generally used to distribute, store, and communicate data limited the efficient extraction of scientific results from space missions.

To improve data access and quality, the report recommended the following steps:

- Greater development and use of software standards,
- More emphasis on data documentation,
- Use of more modern technology,
- More frequent updating of computing facilities, and
- Active involvement of scientists in the planning, acquisition, processing, and archiving of data in order to maximize the science return.

In the intervening years, NASA has taken numerous steps to implement this recommendation.

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2. Telecommunications

NASA's major telecommunications systems serve to acquire, transmit, and distribute space science data obtained from the agency's satellites, scientific probes, and spacecraft in low earth orbits. At present, NASA has two telecommunication systems, the spaceflight tracking and data network, and the space network. NASA's data processing and analysis requirements will grow tremendously when such future operations as the Space Station, the shuttle, and the Hubble Space Telescope contribute to the data traffic. Therefore the agency is formulating its plans to handle the data demands with more advanced telecommunication systems.

The space network serves to replace the older, ground-based spaceflight tracking and data network. It is a space-based system that uses high orbiting satellites, called tracking and data relay satellites, to relay communications between ground stations at White Sands, New Mexico, and low earth-orbiting spacecraft. NASA plans to rely on the space network to relay data, commands, and telemetry between low earth-orbiting spacecraft and the ground.

NASA uses two different systems for transmitting data among different NASA agency locations. The first, NASCOM, transmits science and telemetry data. The other, called the Program Support Communications Network (PSCN), carried program-level information. Section VC contains more information on the Computer Network System portion of the PSCN. NASA is one of the most active agencies in the use of Local-Area Networks (LANs). LAN usage has increased because LANs are highly effective and cost efficient, as compared to the Wide-Area Networks. At present, the general data and administrative applications are heavily support by the LAN services, while the technical and scientific application will be further developed. The Kennedy Switched-Data Network, described in Section VC, provides a good example of NASA's LAN approach.

As another example of NASA's effort to connect its systems, the Johnson Space Center continues to promote connectivity through its Center Information Network (CIN). CIN achieves compatible communications among all major networks at JSC. It will also support user-to-applications connectivity to all IBM-hosted centers and NASA uniform systems and programs. The CIN is based on IBM's System Network Architecture (SNA) and provides gateways to the Digital Equipment Corporation Network (DECNET) and other local-area networks. Within JSC, the CIN interfaces to the Program Support Communications Network (PSCN) and the Center Telecommunications System (CTS).

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Langley Research Center has established its own LAN, known as Larcnet. It consists of more than 26 Ethernet LANs, linked into a center-wide LAN and a Pronet-10 token-ring backbone network provided by Proteon, Inc. of Westborough, Massachusetts. Larcnet supports multiple data communications protocols simultaneously. It aims to standardize on DoD's TCP/IP family of protocols. The Langley Research Center shares its site with Langley Air Force Base. Although Larcnet currently accommodates Xerox Network Systems (XNS) protocols in addition to TCP/IP, the XNS protocols will be phased out.

Currently, more than 400 computers are connected to Larcnet, including:

- Control Data Cyber supercomputers
- IBM mainframes
- Prime Computer minicomputers
- Digital PDP-11, VAX, and Micro VAX systems
- Sun Microsystems workstations
- Iris Graphics scientific workstations, and
- Various IBM and compatible personal computers

Larcnet supports a variety of transmission media, including high-bandwidth fiber optic cable. This medium resists electrical interference that can cause data transmission errors. It also provides security from electronic eavesdropping and can provide fault-tolerant operation over large geographic distances.

At Ames, a LAN is supporting image storage design initiatives. Avtex Research Corporation, of San Jose, California, installed an optical storage system to interface through the LAN. An Ames worker at a properly equipped personal computer anywhere on the network will be able to search and display digitized images from a data base that will eventually grow to 35,000 items. The image data base resides on two write-once/read-many (WORM) laser drives, provided by Micro Design International of Winter Park, Florida.

In 1976, Kennedy installed fiber optic cable throughout a series of underground ducts. For the past 12 years, it has proven to be an extremely reliable transmission medium. Kennedy uses the cable to support its electro-optics laboratory, where it serves as a reference for systems development and evaluation of new equipment. Kennedy's previous copper-wire communications cable was being eaten away by corrosion and brackish water. However, the current cable has withstood the Florida elements, with little apparent attenuation in signal. Today, NASA

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uses fiber optics for all space center wide-band communications. Plans call for 8,073 miles of optical fiber to be installed in 1989.

On another telecommunications initiative, Ames awarded a $9 million contract to Northern Telecom, Inc. for a 5,000-line Meridian SL-100 integrated services network. The project includes complete system installation, including 4,000 new telephone sets, by the end of 1988. The Meridian SL-100 PBXC can be expanded to support up to 30,000 lines, making it one of the largest capacity fully digital communications systems available today. The agreement also calls for linkages with Northern Telecom's Lanstar local-area network and switched access to public and private wide-area networks.

3. Software

NASA uses a variety of software languages, standards, DBMSs, and utilities to meet its mission requirements. The software issues associated with data management have already been discussed. Several oversight bodies have expressed concern over the interface challenges associated with multiple languages. For example, the Space Transportation System, discussed earlier in this section, must interface software written in Fortran, PL1, HAL, assembly, and C.

In response to this need, NASA has established its own standardized approach to life cycle management of software and information systems. The agency has established the Software Management Assurance Program (SMAP) in order to acquire quality software and minimize software acquisition costs. A large package of software management aids including policy, guidelines, standards, and training has been prepared under the guidance of the SMAP office. The Space Station program will utilize the SMAP standards, which are derived from mil-std 2167, already a widely used military standard for software documentation and life cycle management. Other federal agencies, such as the Coast Guard and the FAA, have expressed an interest in adopting the standards established by SMAP.

NASA has also begun to make growing use of artificial intelligence (AI) in scientific and decision support systems. Goddard recently held a conference in the space applications of AI. NASA's Mission Operations and Data Systems Directorate sponsored the program, which included discussions on machine vision, intelligent user interfaces, fault isolation, and other knowledge-based systems.

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In interviews with INPUT, agency executives expressed high hopes for the future of AI at NASA. For example, in the area of decision support systems, AI can support analysis of photographic scenes data coming back from space. This will reduce the people-intensive aspects of this area.

NASA is making growing use of graphics technology in supporting its mission. The Office of Aeronautics and Space Technology (OAST) at NASA headquarters uses Apple Macintosh systems for a variety of applications. OAST is NASA's primary research and development division. It supervises NASA research facilities at Lewis, Ames, and the Dryden Flight Research Facility at Edwards Air Force Base in California. OAST has awarded a $2.5 million contract to Falcon Microsystems for 168 Macintosh IIs for its own use. The MACs will interface to various installed VAX systems at NASA. In some cases, the MACs will replace old Digital equipment.

E
Budget Trends

Over the past few years NASA's budget has exhibited sharp changes, both up and down. Exhibit V-3 summarizes recent funding information.

EXHIBIT V-3

NASA FUNDING SUMMARY
($ Millions)

	Budget Authority	Outlays
1987 Actual	10,923	7,591
1988 Enacted	8,926	9,112
1989 Proposed	11,488	10,978
1990 Estimated	13,354	12,702
1988-1989 Change		
Amount	+2,562	+1,866
Percent	+ 29	+ 29

Within this proposed budget, NASA's research and development budget increased 33% to $4.45 billion. This increase is intended to primarily support Space Station funding. However, it also includes some additional funding for unmanned scientific and applications programs.

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In congressional testimony regarding the proposed NASA budget for FY1989, NASA Administrator James C. Fletcher stated that this will be the year that NASA resumes the Space Shuttle flights and plans to further promote its goal of extended exploration of the solar system. The FY 1989 budget proposes a total of $11.5 billion in new budget authority:

- Space Flight, Control, and Data Communications, $4.8 billion,
- Construction of Facilities, $285 million, and
- Research and Program Management, $1.9 billion.

Most of the budget increase is required to carry forward the ongoing programs approved by Congress in FY1988, particularly in the Space Transportation and Space Station programs.

Dr. Fletcher also noted that the FY1989 budget will directly support the expansion of the private sector's role in space. For the Space Station, NASA plans to consult with OMB to revise its guidelines on commercialization. The guidelines will be published in the Commerce Business Daily for industry's use in submitting and reviewing proposals.

Exhibit V-4 summarizes funding for some of NASA's major programs:

EXHIBIT V-4

MAJOR NASA PROGRAM FUNDING
($ Million)

	FY88	FY89
Space Station	392	967
Space Science & Applications	1,570	1,860
- X-Ray Astronomy Satellite	–	27
- Mars Observer	51	102
- Life Science Flight Experiments	79	102
Ocean Topography Experiment	75	98
Upper Atmosphere Research Satellite	90	104
Space Communications	95	16
Pathfinder	–	100
Space Shuttle Production	1,100	1,400
Space Shuttle Operations	1,800	2,400
Aeronautical Research Technology	335	414

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The press has widely reported sharp differences in Congress over the NASA budget. The severity of the problem led Dr. Fletcher to write a letter to the Congress. The letter said, in part, that he would ". . .seriously consider terminating all the recently awarded Space Station development contracts." NASA was apparently surprised by the negative reaction from The Hill. At this writing, it is not clear how this funding fight will be resolved. Recently, a Senate subcommittee cut NASA's budget to $9.89 billion.

In performing its mission, NASA relies heavily on information technology and spends about 10 percent of its annual budget on this technology. According to the Office of Management and Budget, NASA is planning to acquire more information technology over the next 5 years than almost every other federal civilian agency. The agency's long-range plan for fiscal years 1987 through 1991 lists 460 projects costing $1 million or more over this 5-year period, totaling $4.1 billion. These projects fall under several categories, as shown in Exhibit V-5.

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EXHIBIT V-5

MAJOR NASA INFORMATION TECHNOLOGY PROJECTS FISCAL YEARS 1987 THROUGH 1992

Category	Number of Projects	Estimated Cost (Thousands)	Percentage of Total Cost
Aeronautical Research and Technology Base	126	$856,932	20.96
Space Transportation Operation Program	45	701,420	17.15
Space Science and Applications	73	607,217	14.85
Shuttle Production and Operations Program	56	549,515	13.44
Space and Ground Network Communication and Data Systems	44	357,362	8.74
Launch and Landing Operations	13	297,446	7.27
Resources and Program Management	38	215,039	5.26
Space Station	22	176,965	4.33
Tracking and Data Acquisition	12	140,020	3.42
Flight Operations	15	118,487	2.90
Other	6	32,230	0.79
Orbiter	7	30,194	0.74
Space Research and Technology Base	3	3,856	0.09
Life Science	1	2,388	0.06

Source: GAO/IMTEC-87-20 NASA's Use of Information Technology
Report to the Chairman, Committee on Sciences, Space and Technology,
General Accounting Office, April, 1987.

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Acquisition Plans and Procedures

A

Use of Information Services Vendors

NASA is using information services vendors primarily because of in-house staffing limitations, budget constraints, and because the contractors provide experience and expertise that is not available extensively within the agency. Exhibit VI-1 depicts the percent of surveyed agency respondents that are currently using each service category and that category's average share of the respondents' information technology budgets.

EXHIBIT VI-1

TYPES OF INFORMATION SERVICES CONTRACTED FOR BY NASA RESPONDENTS

Service Category	Percent of Respondents Currently Contracting for Service	Average Percentage Share of Respondents' I.T. Budgets
Professional Services	100	15
Hardware	100	23
Software	92	24
Telecommunications	92	8
Systems Integration	85	9
Facilities Management	62	13
Processing Services	38	8

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The NASA agency respondents represent a wide distribution of both headquarters offices and the NASA research and space centers. Therefore their specific information service requirements and I.T. budgets are diverse. With the exception of processing services, the majority of surveyed organizations are currently contracting for all of the various categories of information services.

B
Changes in Contracted Services

Exhibit VI-2 reflects the NASA agency respondents' projected changes for contracted services over the next five years. The largest percentage of respondents anticipate increases in telecommunications, software, and hardware services. This is in sharp contrast to the vendor respondents that expected the largest increases to occur in the acquisition of professional services and systems integration contracts. The differences in the agency and vendor perceptions of future increases in services may stem from their varied classification of services and different orientations to the time frames for design and implementation of NASA's major programs. This result is to be expected in the decentralized environment in which NASA operates.

EXHIBIT VI-2

NASA AGENCY-PROJECTED CHANGES FOR INFORMATION SERVICES CONTRACTING OVER THE NEXT FIVE YEARS

Service Category	Average Percent of Respondents			
	Expected Increase	Expected Decrease	No Change	Average Change (Percent Increase)
Telecommunications	46	–	54	28
Software	46	–	54	25
Hardware	46	–	54	20
Professional Services	38	–	62	13
Systems Integration	31	–	69	10
Facilities Management	23	–	77	30
Processing Services	23	–	77	17

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NASA respondents were queried as to what mission changes, if any, were driving changes in information services. Sixty-five percent of those interviewed stated that adjustments to the agency's mission were a factor contributing to changes in spending for contractor services. Exhibit VI-3 lists the most frequently cited programs and operations for which mission changes will impact expenditures.

EXHIBIT VI-3

MISSION CHANGES DRIVING INFORMATION SERVICES EXPENDITURES

- Space Station
- Shuttle Flight Operations
- Telemetry Data Research Satellite (TDRS)
- Space Telescope
- Civilian Space Initiatives

C Application Areas

The various NASA research and space centers, as well as the headquarters sites surveyed, utilize information services contracts for many different applications. INPUT categorized the responses in Exhibit VI-4, which is a listing of general function and applications categories for the contracted services.

EXHIBIT VI-4

NASA FUNCTIONS AND APPLICATIONS BEING CONTRACTED

- Systems Operations
- Space Station Program
- Research and Technical Operations
- ADP Support Services
- Software Development
- System Engineering and Analysis Support
- Tracking Operations
- Maintenance
- Administrative Applications
- Telecommunications

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The predominant applications for which services are contracted are those associated with general data processing in support of the agency's mission and computer systems requirements. Besides technical or scientific applications, the agency also has many specific "mission-oriented" applications that require custom software development and engineering services that are contracted to vendors. Other applications cover a range of information systems and appear unique to the individual needs for each segment of the agency.

NASA respondents were also asked whether the agency usually transfers continued support in-house or leaves support with the contractors when a commercial services contract is completed. The majority (71%) of the NASA agency respondents stated a preference for continuing the support services through a contractor. When the agency respondents were queried about whether there were any additional ADP support applications that would be converted from in-house to contractor, only 13% of the respondents replied that there were any services not already being contracted that would be converted. The additional applications cited include programming, operations and maintenance, and facilities management.

D

Vendor Types

Respondents were asked which type of vendor appears more desirable for performing their required information services (see Exhibit VI-5). Based on frequency of mention, professional service vendors were preferred, while a large share of the agency respondents also used "all types of organizations."

EXHIBIT VI-5

NASA AGENCY VENDOR TYPE PREFERENCE FOR INFORMATION SERVICES

Vendor/Organization Type	Agency Respondent Ranking*
Professional Services Firms	1
"All" Types	2
Communications Firms	3
Aerospace Companies	4
Hardware Manufacturers	5

* Based on frequency of mention by respondents

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The respondents based their selection of a type of organization on whether the chosen firm met a variety of needs and was knowledgeable in specialized applications. NASA has some unique experience requirements for vendors in order for them to be suitable to participate in certain types of technical projects. Presumably, the agency does not believe that all vendors are capable in all areas; rather, it views vendors according to the vendor's own skill focus and prefers to match that focus to the requirements of the project. Therefore, the communication firms, aerospace companies, and hardware manufacturers come into the program when their particular skills and products are closely tied to the requirements of the system or project.

E

Selection Criteria

The ranking by NASA representatives as to which criteria are most important in the selection of an information services vendor is shown in Exhibit VI-6. The criteria viewed as the most important by both the agency and vendors is the proposed technical solution. Life cycle cost was the second most important criterion according to the agency ranking, whereas the vendors placed initial cost second. The agency respondents ranked initial cost least important.

EXHIBIT VI-6

RELATIVE RANKING OF CRITERIA USED IN SELECTING AN INFORMATION SERVICES VENDOR

Selection Criteria	Agency Ranking*	Vendor Ranking*
Proposed Technical Solution	1	1
Life Cycle Cost	2	3
Contract Type	3	5
Risk Containment Procedures	4	4
Initial Cost	5	2

* Ranking based on an average of the level of respondents ratings.

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F

Contract Types

The NASA respondents surveyed indicated a clear preference for using cost-plus types of contracts for most information services, as shown in Exhibit VI-7. Cost-plus-award-fee contracts are most common. In the procurement of telecommunication services and hardware, the agency prefers fixed-price contracts. The vendor community was evenly split in its opinions of whether cost-plus, fixed-price, or a "mix" of contract types would dominate over the next five years as the most preferred contract vehicle.

EXHIBIT VI-7

NASA AGENCY CONTRACT TYPE PREFERENCE FOR INFORMATION SERVICES

Services Category	Respondents Contract Type Preference		
	Cost-Plus (Percent)	Fixed-Price (Percent)	Mixed (Percent)
Professional Services	66	3	—
Facilities Management	47	40	13
Software	40	40	20
Processing Services	54	46	—
Systems Integration	61	31	8
Telecommunications	27	53	20
Hardware	6	94	—

G

Method for Acquiring Future Services/Systems

NASA plans to meet its future information services and system requirements in a variety of methods as shown in Exhibit VI-8. According to those surveyed, thirty percent anticipate that they will buy hardware components separately and integrate in-house. Twenty-five percent (each) plan to either purchase system components and use an integration contractor or to buy a complete integrated system. Like the Department of Energy and some Commerce agencies, but unlike most other agencies, NASA acquires components separately in a majority of cases.

NASA is increasing its reliance on systems integrators to develop, upgrade, or replace automatic data processing systems. Also, demands from all parts of the agency for additional MIS support are mounting. Furthermore, systems integration is being used to assist the agency in the automation of information systems that support mission activities that now require better solutions to handle diverse applications.

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EXHIBIT VI-8

AGENCY METHODS FOR ACQUIRING NEW OR ENHANCED SERVICES AND SYSTEMS

Method	Percent of Respondents
Buy Components and Integrate In-House	30
Buy Components and Use an Integration Contractor	25
Buy Integrated Systems	25
Combination of Methods	20

Systems that exist to handle data from the various research and space centers, as well as within headquarters, need to be integrated to facilitate document exchange capabilities. Concerns with transmission speeds and storage size requirements will remain key concerns to NASA in its design and development of integrated systems. NASA has recognized the need to incorporate technological advances and add new capabilities.

H

Budget Constraints

The Gramm-Rudman-Hollings Act imposed cuts in federal agency expenditures in 1986 and 1987 that resulted in limitations in the growth in some areas of the information services market. NASA respondents were asked about the impact, if any, that Gramm-Rudman-Hollings and other budgetary constraints had on their acquisition of services. The Act had limited direct influence on most agency respondents; however, it did cause some delays or postponements of services. The areas reported to be the most affected are the scientific programs.

I

Standards

Agency respondents were asked what standards they perceive as having an impact on their agency's acquisition of information services and computer systems. As shown in Exhibit VI-9, agency policymakers and planners face increasingly complex choices regarding the selection and enforcement of telecommunications standards. Such standards, however, are a key element of agency strategies to achieve interconnection and interoperability for existing and planned systems at NASA. In terms of ranking, respondents did not stress any particular standards over others.

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EXHIBIT VI-9

STANDARDS THAT IMPACT AGENCY ACQUISITION OF INFORMATION SERVICES AND COMPUTER SYSTEMS

- OSI Network Standards
- Communication Protocols
- UNIX
- POSIX
- File Exchange Standards
- GOSIP
- SQL Standards

J Agency Perspectives—Industry Trends and Technology

INPUT asked agency officials their views on industry trends and major technological developments in the areas of telecommunications, end-user computing, and information management—areas that will impact future NASA spending on information services. (See Exhibit VI-10.) NASA has technically oriented concerns regarding developments in telecommunications that, when resolved, will serve to extend both the headquarters' and space centers' communication capabilities.

NASA's end-user computing is critical to its space operations. The advancements outlined in Exhibit VI-10 point out the agency's reliance on powerful computers and graphics capabilities, which are perceived as undergoing improvements.

Data storage and software developments are the major concerns of the NASA respondents as they look to the future for information management at NASA. NASA's continued push for state-of-the-art technology will serve to make the vendor community strive to deliver storage devices suitable to NASA's unique requirements.

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EXHIBIT VI-10

INDUSTRY TRENDS AND TECHNOLOGICAL FACTORS AFFECTING FUTURE NASA SPENDING FOR INFORMATION SERVICES

Telecommunications
- Standards Development and Interconnectivity
- Greater Use of Distributed Networks and Improvement to LANs
- Improved Speed of Data Transmission
- Developments in Fiber Optics
- Extensive Interagency Networks
- Developments in Artificial Intelligence

End-User Computing
- Improved Capabilities of Workstations
- More-Powerful Computers at Lower Cost
- Software Productivity Improvements
- Increased Use of Distributed Computing
- Supercomputers at Workstations
- Advancements in Graphics Capabilities

Information Management
- Need to Incorporate Graphics into Data Base Management
- Develop Common User Interfaces with UNIX
- Improvements in Optical Disk Storage
- On-Line Storage for Massive Amounts of Data
- Use of Smart-Card Technology for Exchange of Data
- Greater Software Portability

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VII

Vendor Views

A

Products and Services

The vendors surveyed provided to NASA each of the categories of information services as shown in Exhibit VII-1. The largest share of vendors provided both professional services and software services and products under their current contracts. Additional related services offered by the vendors included technical and scientific support services.

EXHIBIT VII-1

TYPE OF INFORMATION SERVICES PROVIDED TO NASA BY RESPONDENTS

Service Category	Percent of Respondents Currently Providing Service
Professional Services	100
Software & Related Services	90
Systems Integration	80
Facilities Management	70
Hardware	60
Processing Services	60
Telecommunications	50

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Vendors plan to continue to provide a wide range of information services in the future to respond to the demands of NASA's space mission and information technology needs. Exhibit VII-2 profiles the vendors' ranking of the services they perceive as presenting the most opportunity for contracts at NASA over the next 2 to 5 years. Professional services heads the list, followed by systems integration. The vendors also view NASA as still relying on the purchase of additional hardware and software to support its operations.

EXHIBIT VII-2

VENDOR RANKING OF MOST ATTRACTIVE OPPORTUNITIES FOR PRODUCTS AND SERVICES AT NASA

Product/Services	Rank
Professional Services	1
Systems Integration	2
Hardware	3
Software	4
Telecommunications	5

The reasoning behind the vendors' ranking of future opportunities for contracted information services is NASA's adherence to the OMB A-76 policy for contracting professional services, as well as the agency's utilization of a single contractor to be responsible for all aspects of integrating a system. These same factors also hold true for Exhibit VII-3, which identifies the expected percent changes in each service category over the next few years.

B

Changes in Contracted Services

Eighty percent of the industry respondents expected large increases in NASA's procurements for systems integration services (50% increase) and professional services (38% increase). The percent of expected increase for each service is an industry average derived from the respondents' views of the future growth in the NASA agency marketplace for these services, based on their own current contracting experiences. No vendors foresee any decreases in contracting services.

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EXHIBIT VII-3

VENDOR-EXPECTED CHANGE IN CONTRACTING FOR INFORMATION SERVICES AT NASA

Service Category	Percent of Respondents			Average Change (Percent of Increase)
	Expected Increase	Expected Decrease	Expect No Change	
Systems Integration	80	–	20	50
Professional Services	80	–	20	38
Software and Related Services	60	–	40	25
Telecommunications	30	–	70	11
Facilities Management	30	–	70	10
Processing Services	30	–	70	7
Hardware	20	–	80	32

These vendor projections of changes in contracting for information services differ in all but one service category from the changes expected by NASA agency respondents. The single area of agreement on potential rate of growth is software, with an anticipated rate of 25%. In the agency survey results (See Exhibit VI-2), the NASA respondents estimated that contracting for systems integration services would increase by only 10% (versus vendor expectations of 50%), and that professional services would increase by 13% (as compared to 38% in vendor estimates). These smaller growth figures may have been derived from the agency respondent perceptions that these services are fully contracted already. The next nearest category to software growth (in terms of agreement) is hardware, with vendors expecting 32% and agency personnel estimating 20%.

C Application Areas

The vendors were queried as to which application areas are using contractor support throughout NASA. The listing in Exhibit VII-4 includes the general areas in which industry respondents are currently supporting information services.

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EXHIBIT VII-4

APPLICATION AREAS FOR CONTRACTED INFORMATION SERVICES AT NASA

- Scientific Data Applications
- Facilities Management
- Engineering
- Business Systems
- Program Support Systems
- Document Transfer System
- Data Base Management
- Document Image Processing
- Office Automation
- Administrative
- Mission Operations Support
- Command and Control
- Training
- Networks

D

Mission-Oriented Contracts and Applications

Historically, mission-oriented contracting was to be a joint venture between NASA, the business community, and the academic community. Universities were to receive a large share of the R&D money. Presently, most of the R&D functions are contracted to a variety of vendors, as well as to universities and not-for-profit organizations.

The majority (70%) of the vendors surveyed have been awarded "mission-oriented" contracts from NASA. The applications include data analysis, operations support, engineering support, applications software, and portions of both the Space Shuttle and Space Station programs.

E

Selection Criteria

Both the vendors and NASA agency respondents considered the proposed technical solution the number one selection criterion for a contract award, as shown in Exhibit VII-5. The vendors rated initial cost the second most important factor, whereas the agency respondents concluded it was of least importance. Vendors commented that from their own viewpoint, NASA has become more attuned to cost and risk in its consideration of contracts.

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EXHIBIT VII-5

COMPARATIVE RANKING OF SELECTION CRITERIA FOR CONTRACT AWARD AT NASA

Vendor Rank*	Criterion	Agency Rank*
1	Technical Solution	1
2	Initial Cost	5
3	Life Cycle Cost	2
4	Risk Containment Procedures	4
5	Contract Type	3

* Note: Ranking based on average of the level of respondents' ratings.

F

Preferred Contract Types

Vendors provide information services to NASA under a variety of contract types.

- Cost-plus contracts provide for vendor costs to be paid and a fee added that is either negotiated (cost-plus-fixed-fee) or based upon the performance of the contractor in satisfying the contract requirements (cost-plus-award-fee). Cost-plus contracts regulate the margin of profit allowed, but clearly place the risk with the government.

- Fixed-price contracts commit vendors to perform and complete a contract at a predetermined price ceiling. To a significant extent, the profitability associated with a fixed-price contract is dependent upon the vendor's ability to accurately appraise, in advance, the cost of providing services. Successfully managing fixed-price contracts requires an extremely well written and detailed statement of work and project scope. The risk of completion is placed on the vendor.

As presented in Exhibit VII-6, the vendors were also evenly split in their views of which contract type will dominate at NASA over the next five years. Vendors will continue to prefer a mixture of types of contracts in order to minimize their financial risks. This particularly applies to programming and analysis contracts where the financial risks are substantial.

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EXHIBIT VII-6

VENDOR PREFERENCE FOR CONTRACT TYPE WITH NASA

Preferred Contract Type	Percent Vendors
Cost-Plus	35
Fixed-Price	35
Mix	30

Vendors based their contract preferences on their own experience as incumbents for NASA contracts as well as the nature of their products. They did not see any effect on the industry from whichever contract vehicle is utilized. However, they did comment that to a greater extent contract selection by the agency should take into consideration how well defined the requirements are for the system. Lastly, vendors were concerned that with greater use of fixed-price contracts, contract management becomes more critical.

G

Industry Factors Affecting NASA Spending

Vendors surveyed by INPUT suggested numerous industry factors that could increase or decrease NASA's spending on information services in the next two to five years. INPUT grouped these factors into the five categories presented in Exhibit VII-7.

NASA contractors are very aware of the impact of the standards being established through a consensus of federal regulatory and standards organizations, industry organizations such as ANSI and IEEE, and the vendor community. NASA itself has several programs that coordinate standardization efforts for the agency. Most notable is the Software Management Assurance Program (SMAP), which functions to provide a standardized approach to life cycle management of software and information systems, and is being used for the Space Station Program.

Progress toward development of OSI standards is being realized through the recent cooperation of the U.S. industry and governmental efforts. OMB is considering mandating the use of OSI-compatible systems throughout the federal government. The issuance of a governmentwide policy for OSI would help to aggregate the market and establish consistency with commercial product development throughout NASA.

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EXHIBIT VII-7

RANKING OF INDUSTRY FACTORS AFFECTING FUTURE SPENDING FOR INFORMATION SERVICES

Factor	Rank*
Developments in OSI Model and Standards	1
Expanded Applications for Artificial Intelligence	2
Establishment of Ada Requirements	3
Increased Applications for Supercomputer	4
Changes in Methods of Distributed Processing	5

* Rank based on frequency of mention by respondents

Vendors also anticipate that NASA will be implementing artificial intelligence capabilities to support data processing control and handling functions, and safety applications for systems. NASA's Goddard Space Flight Center held a conference that included presentations on machine vision, intelligent user interfaces, fault isolation, knowledge-based systems and other AI topics as sponsored by NASA's Mission Operations and Data Systems Directorate.

NASA is one of the key civilian agencies to support and promote Ada. Vendors' comments indicated that they foresee the agency putting more effort into establishing Ada requirements for space programs over the next five years. Most of the vendors that support NASA will be migrating to the use of Ada to keep pace with future requirements.

The agency makes extensive use of supercomputers and is placing them throughout various locations for greater accessibility. NASA's use of supercomputers will be extended to applications that focus on each of its field installation's main functions and mission support activities. Furthermore, respondents noted that NASA is promoting UNIX and Ada requirements for supercomputer applications.

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H

Technological Trends

The vendors interviewed for this report were asked to identify technological trends that might specifically influence NASA's procurements for information services. As should be expected, the perspectives varied with the primary level of business and the degree of involvement at NASA.

The technical trends identified varied widely. In descending order of frequency of mention, there were several principal trends as identified in Exhibit VII-8. Increased data storage capabilities was cited the most often. Vendors said that the increase in storage requirements for large quantities of data will become even more severe with implementation of the Space Station programs and the return of Shuttle operations.

EXHIBIT VII-8

TECHNOLOGICAL TRENDS THAT IMPACT FUTURE INFORMATION SERVICES ACQUISITIONS

Factor	Rank*
Increased Storage Capabilities	1
State of Art Technology for Graphics	2
Compatibility of Architectures	3
Improved Telecommunications Capabilities	4
Advancements in Networking Standards	5

* Rank based on frequency of mention by respondents.

NASA is viewed by some respondents as being one of the key federal agencies to push for state-of-the-art graphics and networking capabilities. Future graphics techniques, especially those that can be handled at the end user's workstation, will greatly enhance NASA's ability to handle and manipulate scientific data. Also in the future, resolving the interconnecting problems of the present system architectures and improving telecommunications capabilities will extend many of NASA's networks and data systems to a wider audience of potential users and unite their various sites. NASA is also viewed as migrating toward the networking of their supercomputers, thus moving NASA to the leading edge of supercomputer technology.

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I Marketing Differences

Industry respondents were asked to comment on what they perceive as marketing differences between NASA and other government agencies. Their responses are exhibited in Exhibit VII-9. As might be expected, NASA shows a greater technological orientation. Through the relative autonomy of the centers, NASA usually contracts in a highly decentralized fashion.

EXHIBIT VII-9

NASA AGENCY MARKETING DIFFERENCES FROM OTHER GOVERNMENT AGENCIES

NASA Marketing Differences	Rank*
Greater Technological Orientation	1
Decentralized Contracting	2
Increased Client Longevity	3
Limited Classified Data Areas	4
Higher Degree of Professionalism	5

* Rank based on frequency of mention by respondents.

In addition, respondents stated that there appears to be a longer client longevity at NASA, meaning that it was common to maintain the same vendor on a particular project for a lengthy time. For marketing purposes NASA was favorably considered to have a limited classified data area, as compared to some of the DoD agencies. Also viewed as a benefit to the vendors in their marketing to NASA was the fact that the industry respondents have the opinion that NASA's personnel display a higher degree of professionalism than most federal agencies.

J Suggested Improvements to Products and Services

The industry respondents were asked what they believe vendors need to do over the next five years to make their products and services more valuable to the federal government. The replies varied due to the different types and levels of experience the vendors have encountered with the NASA agency. In descending order of frequency of mention, Exhibit VII-10 lists the principal suggestions made by the respondents.

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EXHIBIT VII-10

SUGGESTED IMPROVEMENTS TO PRODUCTS AND SERVICES

Suggestion	Rank*
Become More Solution Oriented	1
Improve Product Compatibility	2
Increase Flexibility to Respond to Changing Requirements	3
Acquire Personnel with Proper Background and Skills	4
Reduce and Control Costs	5
Improve Software Engineering Tools	6

* Rank based on frequency of mention by respondents

The suggestion to become more solution oriented was cited most frequently as a means of making vendor services more valuable to NASA. To the extent that providing "solutions" will aid the vendors' ability to be more responsive to the agency's needs, vendors should adopt this orientation. However, this finding is somewhat at odds with the agency survey, which still showed a preference for buying components separately. However, the need for improved product compatibility was right on the money. The increasing sharing of NASA data, both within and between centers, will drive the compatibility need.

The hiring and training of the proper personnel to work on a government-awarded contract is an area of growing concern throughout the information services industry. Employing staff with the proper background to match NASA's specialized scientific and engineering task requirements is viewed by the vendors as an area that needs to be improved in the future. Vendors also find that developing methods to reduce and control costs and to improve software engineering tools will benefit both NASA and the vendors in the long run.

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Key Opportunities

This section describes specific opportunities in the NASA information technology market. The opportunities list consists of major programs that are typical of the NASA market and serves as a representative sample.

A Present and Future Programs

Funding for NASA is provided in several federal budget categories.

New NASA opportunities that are larger than $1-2 million are listed in at least one of the following federal government documents:

- OMB/GSA Five-Year Plan, which is developed from agency budget requests submitted in compliance with OMB Circular A-11.
- Agency long-range information resource plans developed in response to reporting requirements of the Paperwork Reduction Act of 1980.
- Agency annual operating budget requests submitted to both congressional oversight and appropriations committees based on the OMB A-11 information.
- Commerce Business Daily notice of specific opportunities, for qualifications as a bidder, and to obtain a copy of the RFP or RFI.

NASA opportunities are also identified in internal documents, such as the Information Technology System Plan (ITSP). Each NASA site submits this internal planning document for each fiscal year. INPUT has acquired four of these plans and is in the process of acquiring the remainder.

NASA tends to use integration contracts for larger, more complex systems. NASA programs may be included in these contracts, rather than being met through separate acquisitions.

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The list of opportunities becomes smaller after FY 88 because new programs have not yet been identified or initially approved by NASA. The INPUT *Procurement Analysis Reports* will include additional programs and detailed program information for FY 1988 to FY 1993.

All funding proposals are based on cost data of the year submitted, with inflation factors dictated by the Administration as part of its policy, and subject to revision, reduction, or spread to future years in response to congressional direction.

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B

NASA Opportunities

Site	Program	PAR Reference	RFP Schedule	FY88-FY93 Funding ($ Million)
ARC	Center-Wide Computer Equipment Maintenance	VIII-15-9	2QFY90	8.5
ARC	Operations Central Computer Facility	VIII-15-12	1QFY91	6.0
LeRC	Archiver/Mass Storage System	VIII-15-26	—	0.9
LaRC	Replace Real-Time Simulation Processors	VIII-15-34	12/88	—
GSFC	UNIVAC 1000s Replacement	VIII-15-36	1QFY89	—
JSC	Shuttle Mission Simulator (SMS), Guidance Navigation Simulator (GNS), Intelligent Controller (IC), and Host Replacement	VIII-15-51	1/88	36.0
JSC	Flight Data System Upgrade	VIII-15-53	—	—
JSC	Replace 9 TPC Systems	VIII-15-54	—	—
LeRC	Class VII Computer System	VIII-15-57	—	20.0
ARC	Numerical Aerodynamic Simulator (NAS), Processing System Network (NPSN)—Graphics Subsystem	VIII-15-59	—	8.3
ARC	Numerical Aerodynamic Simulator, Processing System Network (NPSN), Numbers 3 and 4	VIII-15-60	#3: 7/12/88 #4: FY94	80.963
HQ	Space Station Definition and Preliminary Design Program	VIII-15-61	—	—
GSFC	Customer Data and Operations System (CDOS)	VIII-15-62	8/88	$200-400
HQ	NASA Net	VIII-15-69	—	—
HQ	NASA Occupational Health Management Information System (NOHMIS)	VIII-15-70	—	2.3

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Site	Program	PAR Reference	RFP Schedule	FY88-FY93 Funding ($ Million)
MSFC	Engineering Analysis and Data System (EADS)	VIII-15-71	4QFY89	60.0
KSC	Kennedy Switched Data Network	VIII-15-72	—	—
MSFC	Program Support Communications Network (PSCN)	VIII-15-73	FY94	—
KSC	Launch Processing System II	VIII-15-74	8/88	55.6
LeRC	Class VI Vector Processor	VIII-15-75	7/88	38.4
JSC	Training Systems Center (TSC)	VIII-15-77	7/1/88	350.0
JSC	Mission Systems Contract (MSC)	VIII-15-78	9/88	133.23
HQ	IBM AT-Class Personal Computers	VIII-15-79	8/1/88	—

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Appendix: NASA Information Services Market Interview Profiles

A

NASA Agency Interviews

The interviews were conducted by telephone for 90% of the agency respondents and the remaining 10% were on-site contacts at NASA Headquarters. The respondents interviewed within NASA included administrative policy officials, contracting officers, and program managers.

The following is a list of NASA and GSA offices interviewed:

- Goddard Space Flight Center (3)
- Ames Research Center (2)
- Jet Propulsion Laboratories
- Langley Research Center
- Kennedy Space Center
- Marshall Space Flight Center (2)
- Lewis Research Center
- Johnson Space Center
- Stennis Space Center
- NASA Headquarters (Code TS)
- NASA Headquarters (Code NTD) (3)
- NASA Headquarters (Code R)
- NASA Headquarters (Code NT)
- General Services Administration (Code KMAS)

B

Industry Interviews

For this report, INPUT contracted a representative sample of vendors that provide information services to NASA. Job classifications among individual vendor respondents included marketing as well as administrative executives. All contracts with vendor personnel were made by telephone.

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Appendix: Definitions

The definitions in this appendix include hardware, software, services, and telecommunications categories to accommodate the range of information systems and services programs described in this report.

Alternate service mode terminology employed by the federal government in its procurement process is defined along with INPUT's regular terms of reference, as shown in Exhibit B-1.

The federal government's unique non-technical terminology that is associated with applications, documentation, budgets, authorization, and the procurement/acquisition process is included in Appendix C, Glossary.

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EXHIBIT B-1

FEDERAL INFORMATION SYSTEMS AND SERVICES PROGRAM SYSTEMS AND SERVICES

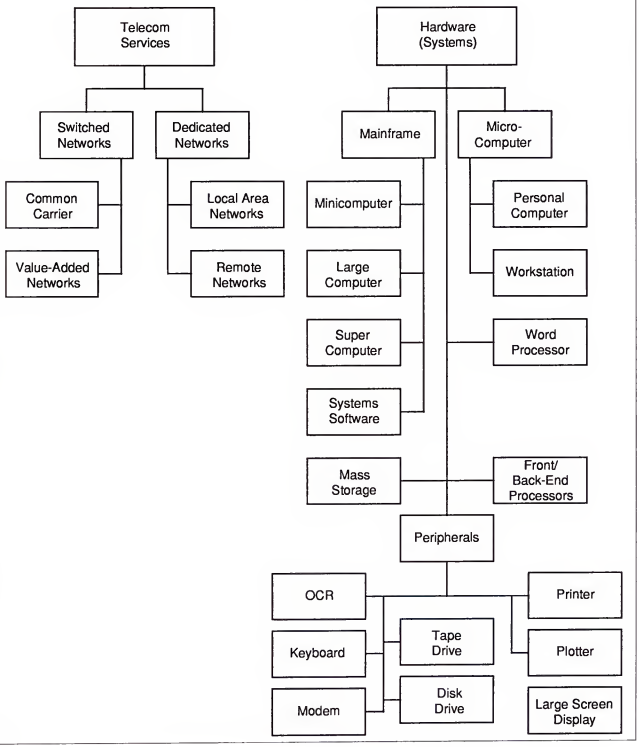

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EXHIBIT B-1 (Cont.)

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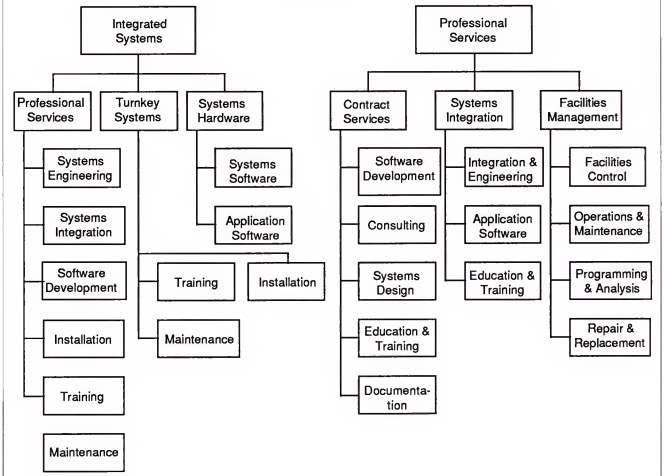

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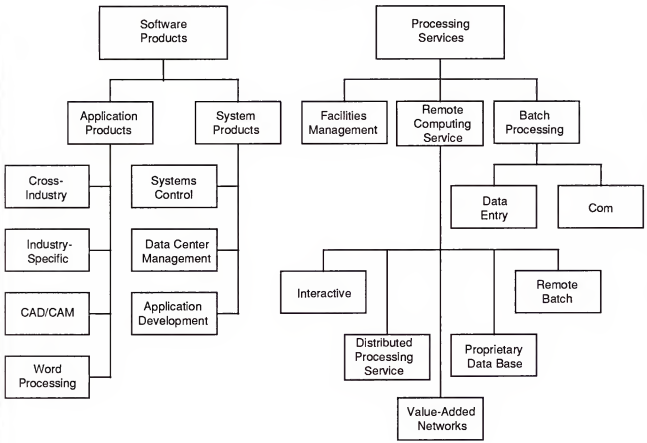
EXHIBIT B-1 (Cont.)

FEDERAL INFORMATION SYSTEMS AND SERVICES PROGRAM SYSTEMS AND SERVICES (Cont.)



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A

Service Modes

1. Processing Services

Processing services include remote computing services, batch services, and processing facilities management.

Remote Computing Services (RCS) - Provision of data processing to a user by means of terminals at the user's site(s). Terminals are connected by a data communications network to the vendor's central computer. The most frequent contract vehicle for RCS in the federal government is GSA's Teleprocessing Services Program (TSP). RCS includes the following submodes.

- *Interactive (timesharing)* - Characterized by the interaction of the user with the system, primarily for problem-solving timesharing but also for data entry and transaction processing; the user is on-line to the program/files.
- *Remote Batch* - Where the user hands over control of a job to the vendor's computer which schedules job execution according to priorities and resource requirements.
- *Proprietary Data Base* - Characterized by the retrieval and processing of information from a vendor-maintained data base. The data base may be owned by the vendor or by a third party or be licensed by a federal agency.
- *Value-Added Network Services* - Special purpose and/or high-quality network specifically designed to carry digital information, with features not usually provided by the voice-grade, switched public network.
- *Distributed Processing Services* - Alternately called "Distributed Data Processing" (DDP) that can provide:
  - Access through the network to the RCS vendor's larger computers.
  - Local management and storage of a data base subset that will service local terminal users via the connection of a data base processor to the network.
  - Availability of significant software that may be "down loaded" as part of the service.

Batch Processing - These include data processing performed at vendors' sites for user programs and/or data that are physically transported (as opposed to transported electronically by telecommunications media) to

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and/or from those sites. Data entry and data output services, such as keypunching and computer output microfilm processing, are also included. Batch services include expenditures by users who take their data to a vendor site that has a terminal connected to a remote computer for the actual processing.

Processing Facilities Management (PFM) - Also referred to as "Resource Management," "Systems Management," or "COCO" (Contractor-Owned, Contractor-Operated). The management of all or part of a user's data processing functions under a long-term contract of not less than one year. This would include remote computing and batch services. To qualify as PFM, the contractor must directly plan, control, operate, and own or lease the facility provided to the user, either on-site, through communications lines, or in a mixed mode.

2. Professional Services

Professional services provide labor-intensive consulting, design, education and training, programming and analysis, management, and systems integrations as defined within these general categories.

- *Contract Services* - Provision of professional and technical services of various skill levels to accomplish specific tasks not specifically or necessarily associated with a delivered product, other than paper or ADP media records. Contracts generally require vendor management of staff and/or resources.

- *Consulting* - Information systems and/or services management consulting, program assistance (technical and/or management), feasibility analyses, and cost-effectiveness trade-off studies.

- *Education and Training* - Products and/or services related to information systems and services for the user, including computer-aided instruction (CAI), computer-based education (CBE), and vendor instruction of user personnel in management operations, programming, and maintenance of systems.

- *Systems Design* - Preparation of systems/sub-systems architecture, specifications, and performance criteria from functional information processing statements or performance of an operations requirements study. May include ADP, telecommunications, site layout, training, and maintenance facilities.

- *Software Development* - Also known as programming and analysis services, this includes applications and systems software design, contract or custom programming, code conversion, independent verification and validation (IV&V), and benchmarking. These services may also include follow-on software development and maintenance.

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- *Documentation Services* - Vendor preparation, modification, or replacement of system operating manuals, software coding records, training manuals, software library records, and equipment modification records.

Professional Services Facilities Management (PSFM) - Also referred to as GOCO (Government-Owned, Contractor-Operated) services. The computing equipment is owned or leased by the client (government), not by the vendor. The vendor provides the staff to operate, maintain, repair, schedule, and manage the client's facility over a term of three to five years. Submodes include:

- *Facilities Control* - Vendor management, including scheduling of resources and personnel, to meet specified operations objectives or produce specified information products, with no direct client supervision.

- *Operation and Maintenance (O&M)* - Vendor operation and maintenance of government-owned ADP/telecommunications equipment in a government-owned/leased facility (on-site) without vendor management of the facility.

- *Programming and Analysis (Support)* - Vendor-furnished professional and technical staff support, which may be provided on or off the client's site, to analyze information processing requirements, plan resource applications, and/or develop/modify/maintain custom software, over a period of time not less than one year. Contracts tend to be task-oriented to control the work flow.

- *Hardware and/or Software Maintenance* - Vendor-furnished services provided after installation and acceptance by the government, where the vendor may not be the original supplier (third-party maintenance or TPM) and may use either on-site or on-call personnel to perform services.

- *Repair and Replacement* - Vendor-furnished services and acquires information system components to repair or replace worn or defective equipment and to add equipment needed to meet new or unusual requirements.

Systems Integration - Services associated with design and integration, software development, and installation and government acceptance of ADP/telecommunications systems. Services may also include related engineering activities such as Systems Engineering and Integration (SE&I) or Systems Engineering and Technical Assistance (SETA).

- *Engineering and Integration* - Vendor-furnished technical services provided separately from acquisition of hardware and software to expand the initial design into specifications, interface descriptions, installation, and operating instructions of the complete system.

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- *Applications Software* - Custom software development to satisfy non-commercially available information processing requirements of an integrated system.

- *Education and Training* - Vendor development of training aids, manuals, and curricula for indoctrinating client management, operation and maintenance, and information product user personnel on the newly integrated information system.

3. Turnkey Systems

Turnkey systems, also known as integrated systems, include systems and applications software packaged with hardware as a single entity. Most CAD/CAM systems and many small business systems are integrated systems. This mode does not include specialized hardware systems such as word processors, cash registers, and process control systems.

4. Software Products

Software products include user purchases of applications and systems packages for in-house computer systems. Included are lease and purchase expenditures, as well as expenditures for work performed by the vendor to implement and maintain the package at the user's sites. Expenditures for work performed by organizations other than the package vendor are counted in the category of professional services. There are several subcategories of software products, as indicated below and shown in detail in Exhibit B-2.

Application Products - Software that performs processing which services user functions. The products can be:

- *Cross-Industry Products* - Used in multiple industry applications as well as in federal government sectors. Examples are payroll, inventory control, and financial planning.

- *Industry-Specialized Products* - Used in a specific federal government sector, such as planning, resource utilization, aircraft flight planning, military personnel training, and others. May also include some products designed to work in an industry other than the federal government but applicable to specific government-performed commercial/industrial services, such as hospital information, vehicular fleet scheduling, electrical power generation and distribution, CAD/CAM, and others.

Systems Products - Software that enables the computer/communications systems to perform basic functions. These products include:

- *System Control Products* - Function during applications program execution to manage the computer system resources. Examples include operating systems, communication monitors, emulators, and spoolers.

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- *Data Center Management Products* - Used by operations personnel to manage the computer systems resources and personnel more effectively. Examples include performance measurement, job accounting, computer operations scheduling, and utilities.

- *Applications Development Products* - Used to prepare applications for execution by assisting in designing, programming, testing, and related functions. Examples include languages, sorts, productivity aids, compilers, data dictionaries, data base management systems, report writers, project control systems, and retrieval systems.

5. Hardware and Hardware Systems

Hardware included all ADP and telecommunications equipment that can be separately acquired by the government with or without installation by the vendor and not acquired as part of an integrated system. For the purpose of this report, hardware is grouped in three major categories: peripherals, terminals, and hardware systems (processors).

Peripherals - Include all input, output, communications, and storage devices other than main memory that can be connected locally to the main processor and generally cannot be included in other categories such as terminals.

- *Input Devices* - Includes keyboards, numeric pads, card readers, light pens and track balls, tape readers, position and motion sensors, and analog-to-digital converters.

- *Output Devices* - Includes printers, CRTs, projection television screens, micrographics processors, digital graphics, and plotters.

- *Communication Devices* - Modems, encryption equipment, special interfaces, and error control.

- *Storage Devices* - Includes magnetic tape (reel, cartridge, and cassette), floppy and hard disks, drums, solid state (integrated circuits), and bubble and optical memories.

Terminals - Federal government systems use three types of terminals as described below.

- *User-Programmable* - Also called intelligent terminals, including:

  - Single-station or standalone.
  - Multi-station shared processor.
  - Teleprinter.
  - Remote batch.

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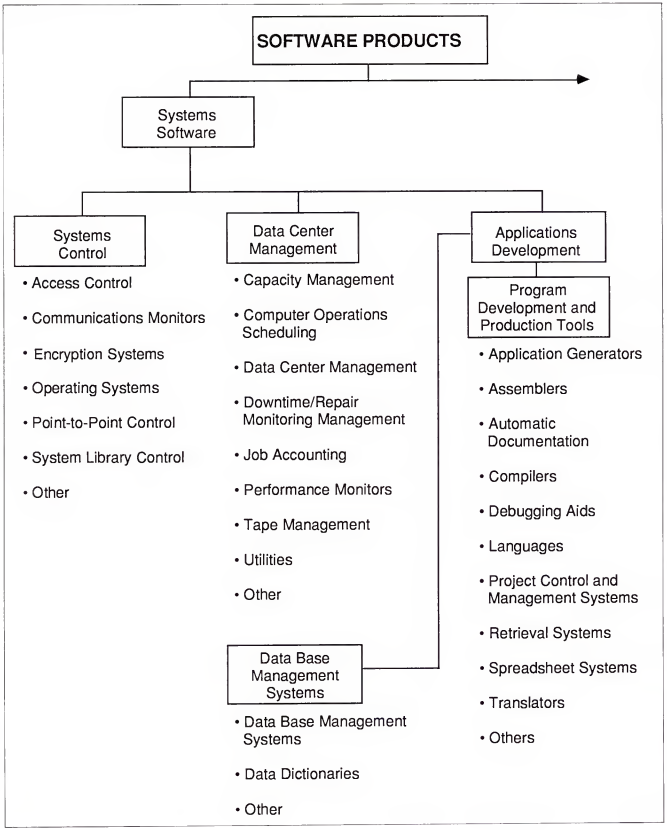
EXHIBIT B-2



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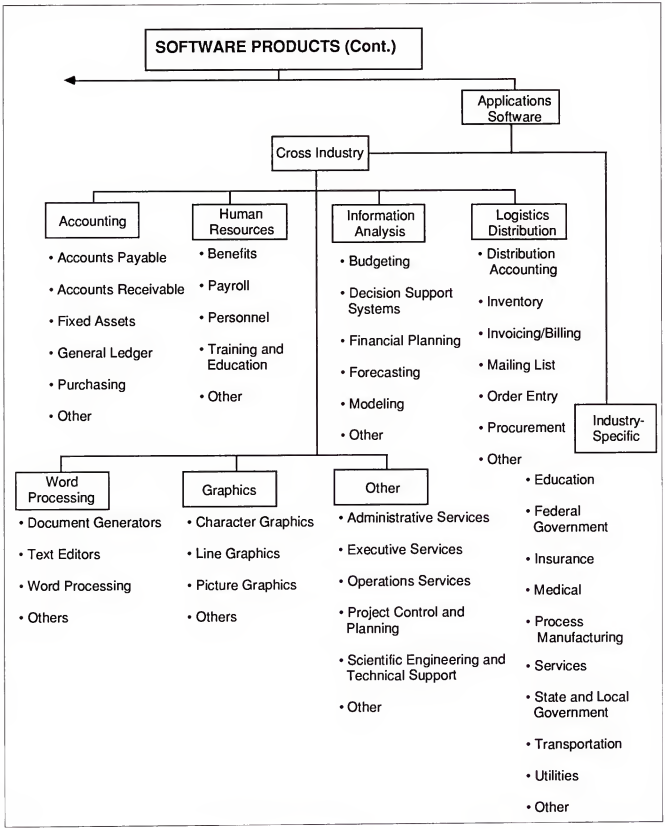

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- *Non-Programmable* - Also called "dumb" terminals, including:
  - Single-station.
  - Multi-station shared processor.
  - Teleprinter.
- *Limited Function* - Originally developed for specific needs, such as point-of-sale (POS), inventory data collections, controlled access, and other applications.

Hardware Systems - Includes all processors from microcomputers to supercomputers. Hardware systems may require type- or model-unique operating software to be functional, but this category excludes applications software and peripheral devices, other than main memory and processors or CPUs not provided as part of an integrated (turnkey) system.

- *Microcomputer* - Combines all of the CPU, memory, and peripheral functions of an 8-, 16-, or 32-bit computer on a chip in the form of:
  - Integrated circuit package.
  - Plug-in boards with more memory and peripheral circuits.
  - Console including keyboard and interfacing connectors.
  - Personal computer with at least one external storage device directly addressable by the CPU.
  - An embedded computer which may take a number of shapes or configurations.
- *Minicomputer* - Usually a 12-, 16-, or 32-bit computer which may be provided with limited applications software and support and may represent a portion of a complete large system.
  - Personal business computer.
  - Small laboratory computer.
  - Nodal computer in a distributed data network, remote data collection network, or connected to remote microcomputers.
- *Midicomputer* - Typically a 32- or 64-bit computer with extensive applications software and a number of peripherals in standalone or multiple-CPU configurations for business (administrative, personnel, and logistics) applications; also called a general purpose computer.
- *Large Computer* - Presently centered around storage controllers but likely to become bus-oriented and to consist of multiple processors or

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parallel processors. Intended for structured mathematical and signal processing and typically used with general purpose, VonNeumann-type processors for system control.

- *Supercomputer* - High-powered processors with numerical processing throughput that is significantly greater than the fastest general purpose computers, with capacities in the 10-50 million floating point operations per second (MFLOPS) range. Newer supercompu-ters, with burst modes approaching 300 MFLOPS, main storage size up to 10 million words, and on-line storage in the one-to-three gigabyte class, are labeled Class IV to Class VII in agency long-range plans. Supercomputers fit in one of two categories:

  - *Real Time* - Generally used for signal processing in military applications.

  - *Non-Real Time* - For scientific use in one of three configurations:

    ° Parallel processors.
    ° Pipeline processor.
    ° Vector processor.

  - *Super( )computer* - Term applied to micro, mini, and large mainframe computers with performance substantially higher than attainable by VonNeuman architectures.

- *Embedded Computer* - Dedicated computer system designed and implemented as an integral part of a weapon, weapon system, or platform; critical to a military or intelligence mission such as command and control, cryptological activities, or intelligence activities. Characterized by military specifications (MIL SPEC) appearance and operation, limited but reprogrammable applications software, and permanent or semi-permanent interfaces. May vary in capacity from microcomputers to parallel processors computer systems.

6. Telecommunications

Networks - Electronic interconnections between sites or locations which may incorporate links between central computer sites and remote locations and switching and/or regional data processing nodes. Network services typically are provided on a leased basis by a vendor to move data, voice, video, or textual information between locations. Networks can be categorized in several different ways.

- *Common Carrier Network* - A public access network, such as provided by AT&T, consisting of conventional voice-grade circuits and regular switching facilities accessed through dial-up calling with leased or user-owned modems for transfer rates between 150 and 1,200 baud.

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- *Value-Added Network (VAN)* - Provided by vendors through common carrier or special-purpose transmission facilities with special features not available in the voice-grade switched public network. These include:

  - *Dedicated Network* - Also known as a private network, established and operated for one user or user organization using dedicated circuits to establish permanent connections between two or more stations.

  - *Packet Switching* - Real time network routing, transmitting, and receiving data in the form of addressed packets, each of which may be part of a message or include several messages without exclusive use of a network circuit by the transmitting and receiving stations.

  - *Message Switching* - Non-real time process for routing messages through network where a user message is received, stored, and forwarded from switch to switch through the network without an end-to-end circuit between sending and receiving stations; used primarily for data.

- *Local Area Network (LAN)* - Limited-access network between computing resources in a relatively small (but not necessarily contiguous) area, such as a building, complex of buildings, or buildings distributed within a metropolitan area. Uses one of two signalling methods.

  - *Baseband* - Signaling using digital waveforms on a single frequency band, usually at voice frequencies, and bandwidth, limited to a single sender at any given moment. When used for local area networks, typically implemented with TDM to permit multiple access.

  - *Broadband* - Transmission facilities that use frequencies greater than normal voice-grade, supported in local area networks with RF modems and AC signaling. Also known as wideband. Employs multiplexing techniques that increase carrier frequency between terminals to provide:

    ° Multiple channels through FDM or TDM.
    ° High-speed data transfer via parallel mode at rates of up to 96,000 baud.

Transmission Facilities - Includes wire, carrier, coaxial cable, microwave, optical fiber, satellites, cellular radio, and marine cable operating in one of two modes depending on the vendor and the distribution of the network.

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- *Mode* - may be either:
  - *Analog* - Transmission or signal with continuous waveform representation, typified by AT&T's predominantly voice-grade DDD network and most telephone operating company distribution systems.
  - *Digital* - Transmission or signal using discontinuous, discrete quantities to represent data, which may be voice, data, record, video, or text, in binary form.
- *Media* - May be any of the following:
  - *Wire* - Varies from earlier single-line teletype networks, to two-wire standard telephone (twisted pair), to four-wire full-duplex balanced lines.
  - *Carrier* - A wave, pulse train, or other signal suitable for modulation by an information-bearing signal to be transmitted over a communications system, used in multiplexing applications to increase network capacity.
  - *Coaxial Cable* - A cable consisting of an insulated central conductor surrounded by a cylindrical conductor with additional insulation on the outside and covered with an outer sheath used in HF (high frequency) and VHF (very high frequency), single frequency, or carrier-based systems; requires frequent reamplification (repeaters) to carry the signal any distance.
  - *Microwave* - UHF (ultra-high frequency) multi-channel, point-to-point, repeated radio transmission, also capable of wide frequency channels.
  - *Optical Fiber* - Local signal distribution systems employed in limited areas, using light-transmitting glass fibers and TDM for multi-channel applications.
  - *Communications Satellites* - Synchronous earth-orbiting systems that provide point-to-point, two-way service over significant distances without intermediate amplification (repeaters), but requiring suitable groundstation facilities for up- and down-link operation.
  - *Cellular Radio* - Network of fixed, low-powered two-way radios that are linked by a computer system to track mobile phone-data set units. Each radio serves a small area called a cell. The computer switches service connection to the mobile unit from cell to cell.

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B

General Definitions

103/113 - Bell standard modem for low-speed transmission up to 300 bps, asynchronous, half or full duplex.

212 - Bell standard for medium-speed transmission at 1200 bps, asynchronous or synchronous, half or full duplex.

ASCII - American National Standard Code for Information Interchang—eight-bit code with seven data bits and one parity bit.

Asynchronous - Communications operation (such as transmission) without continuous timing signals. Synchronization is accomplished by appending signal elements to the data.

Bandwidth - Range of transmission frequencies that can be carried on a communications path; used as a measure of capacity.

Baud - Number of signal events (discrete conditions) per second. Typically used to measure modem or terminal transmission speed.

Benchmark - Method of testing proposed ADP system solutions for a specified set of functions (applications) employing simulated or real data inputs under simulated operating conditions.

BPS - Bits per second - also mbps and kbps, million bits per second and thousand bits per second, respectively.

BSC - IBM's binary synchronous communications data link protocol. First introduced in 1968 for use on point-to-point and multipoint communications channels. Frequently referenced as "bisync."

Byte - Usually equivalent to the storage required for one alphanumeric character (i.e., one letter or number).

CBX - Computerized Branch Exchange - a PABX based on a computer system, implying programmability and usually voice and data capabilities.

Central Processing Unit (CPU) - The arithmetic and control portion of a computer; i.e., the circuits controlling the interpretation and execution of computer instructions.

Centrex - Central office telephone services that permit local circuit switching without installation of customer premises equipment. Could be described as shared PBX service.

Circuit Switching - A process that, usually on demand, connects two or more network stations and permits exclusive circuit use until the connec-

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tion is released; typical of the voice telephone network where a circuit is established between the caller and the called party.

CO - Central Office - local telco site for one or more exchanges.

CODEC - Coder/decoder, equivalent to modem for digital devices.

Constant Dollars - Growth forecasts in constant dollars make no allowance for inflation or recession. Dollar value based on the year of the forecast unless otherwise indicated.

Computer System - The combination of computing resources required to perform the designed functions and which may include one or more CPUs, machine room peripherals, storage systems, and/or applications software.

CPE - Customer Premises Equipment - DCE or DTE located at a customer site rather than at a carrier site such as the local telephone company CO. May include switchboards, PBX, data terminals, and telephone answering devices.

CSMA/CD - Carrier Sense Multiple Access/Collision Detect. Contention protocol used in local-area networks, typically with a multi-point configuration.

Current Dollars - Estimates or values expressed in current-year dollars which, for forecasts, would include an allowance for inflation.

Data Encryption Standard (DES) - 56-bit key, one-way encryption algorithm adopted by NBS in 1977, implemented through hardware ("S-boxes") or software. Designed by IBM with NSA guidance.

Datagram - A self-contained packet of information with a finite length that does not depend on the contents of preceding or following packets.

DCA - IBM's Document Content Architecture - protocols for specifying document (text) format which are consistent across a variety of hardware and software systems within IBM's DISOSS.

DCE - Data Circuit-terminating Equipment - interface hardware that couples DTE to a transmission circuit or channel by providing functions to establish, maintain, and terminate a connection, including signal conversion and coding.

DDCMP - Digital Data Communications Message Protocol - data link protocol used in Digital Equipment Company's DECNET.

DECNET - Digital Equipment Company's network architecture.

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Dedicated Circuit - A permanently established network connection between two or more stations; contrast with switched circuit.

DEMS - Digital Electronic Message Service - nationwide common carrier digital networks which provide high-speed, end-to-end, two-way transmission of digitally-encoded information using the 10.6 GHz band.

DIA - IBM's Document Interchange Architecture - protocols for transfer of documents (text) between different hardware and software systems within IBM's DISOSS.

DISOSS - IBM's DIStributed Office Support System - office automation environment, based on DCA and DIA, which permits document (text) transfer between different hardware and software systems without requiring subsequent format or content revision.

Distributed Data Processing - The development of programmable intelligence in order to perform a data processing function where it can be accomplished most effectively through computers and terminals arranged in a telecommunications network adapted to the user's characteristics.

DTE - Data Terminal Equipment - hardware which is a data source or sink or both, such as video display terminals that convert user information into data for transmission and reconvert data signals into user information.

EBCDIC - Extended Binary Coded Decimal Interchange Code - eight-bit code typically used in IBM mainframe environments.

EFT - Electronic funds transfer.

Encryption - Electrical, code-based conversion of transmitted data to provide security and/or privacy of data between authorized access points.

End User - One who is using a product or service to accomplish his or her own functions. The end user may buy a system from the hardware supplier(s) and do his or her own programming, interfacing, and installation. Alternately, the end user may buy a turnkey system from a systems house or hardware integrator, or may buy a service from an in-house department or external vendor.

Engineering Change Notice (ECN) - Product changes to improve the product after it has been released to production.

Engineering Change Order (ECO) - The follow-up to ECNs - they include parts and a bill of materials to effect the change in the hardware.

Equipment Operators - Individuals operating computer control consoles and/or peripheral equipment (BLS definition).

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Ethernet - Local area network developed by Xerox PARC using baseband signaling, CSMA/CD protocol, and coaxial cable to achieve a 10 mbps data rate.

Facsimile - Transmission and reception of data in graphic form, usually fixed images of documents, through scanning and conversion of a picture signal.

FDM - Frequency Division Multiplexing - a multiplexing method that permits multiple access by assigning different frequencies of the available bandwidth to different channels.

FEP - Front-End Processor - communications concentrator such as the IBM 3725 or COMTEN 3690 used to interface communications lines to host computers.

Field Engineer (FE) - Field engineer, customer engineer, serviceperson, and maintenance person are used interchangeably and refer to the individual who responds to a user's service call to repair a device or system.

Full-Duplex - Bi-directional communications with simultaneous two-way transmission.

General Purpose Computer System - A computer designed to handle a wide variety of problems. Includes machine room peripherals, systems software, and small business systems.

Half-Duplex - Bi-directional communications, but only in one direction at a time.

Hardware Integrator - Develops system interface electronics and controllers for the CPU, sensors, peripherals, and all other ancillary hardware components. The hardware integrator also may develop control system software in addition to installing the entire system at the end-user site.

HDLC - High-level Data Link Control.

Hertz - Number of signal oscillations (cycles) per second - abbreviated Hz.

IBM Token Ring - IBM's local area network using baseband signalling and operating at 4 mbps on twisted-pair copper wire. Actually a combination of star and ring topologies – IEEE 802.5-compatible.

IDN - Integrated Digital Network - digital switching and transmission; part of the evolution to ISDN.

Independent Suppliers - Suppliers of machine room peripherals - usually do not supply general purpose computer systems.

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Information Processing - Data processing as a whole, including use of business and scientific computers.

Installed Base - Cumulative number or value (cost when new) of computers in use.

Interconnection - Physical linkage between devices on a network.

Interoperability - The capability to operate with other devices on a network. To be contrasted with interconnection, which merely guarantees a physical network interface.

ISDN - Integrated Services Digital Network - integrated voice and non-voice public network service which is completely digital. Not clearly defined through any existing standards although FCC and other federal agencies are participating in the development of CCITT recommendations.

Keypunch Operators - Individuals operating keypunch machines (similar in operation to electric typewriters) to transcribe data from source materials onto punch cards.

Lease Line - Permanent connection between two network stations. Also known as dedicated or non-switched line.

Machine Repairers - Individuals who install and periodically service computer systems.

Machine Room Peripherals - Peripheral equipment that is generally located close to the central processing unit.

Mainframe - The central processing unit (CPU or units in a parallel processor) of a computer that interprets and executes computer (software) instructions of 32 bits or more.

MAP - Manufacturing Automation Protocol - seven-layer communications standard for factory environments promoted by General Motors/ EDS. Adopts IEEE 802.2 and IEEE 802.4 standards plus OSI protocols for other layers of the architecture.

Mean Time to Repair - The mean of elapsed times from the arrival of the field engineer on the user's site until the device is repaired and returned to user service.

Mean Time to Respond - The mean of elapsed times from the user call for services and the arrival of the field engineer on the user's site.

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Message - A communication intended to be read by a person. The quality of the received document need not be high, only readable. Graphic materials are not included.

MMFS - Manufacturing Messaging Format Standard - application-level protocol included within MAP.

Modem - A device that encodes information into electronically transmittable from (MOdulator) and restores it to original analog form (DEModulator).

NCP - Network Control Program - software used in IBM 3705/3725 FEPs for control of SNA networks.

Node - Connection point of three or more independent transmission points which may provide switching or data collection.

Off-Line - Pertaining to equipment or devices that can function without direct control of the central processing unit.

On-Line - Pertaining to equipment or devices under direct control of the central processing unit.

OSI - ISO reference model for Open Systems Interconnection - seven-layer architecture for application, presentation, session, transport, network, data link, and physical services and equipment.

OSI Application Layer - Layer 7, providing end-user applications services for data processing.

OSI Data Link Layer - Layer 2, providing transmission protocols, including frame management, link flow control, and link initiation/release.

OSI Network Layer - Layer 3, providing call establishment and clearing control through the network nodes.

OSI Physical Layer - Layer 1, providing the mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections to the network.

OSI Presentation Layer - Layer 6, providing data formats and information such as data translation, data encoding/decoding, and command translation.

OSI Session Layer - Layer 5, establishes, maintains, and terminates logical connections for the transfer of data between processes.

OSI Transport Layer - Layer 4, providing end-to-end terminal control signals such as acknowledgements.

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Overseas - Not within the geographical limits of the continental United States, Alaska, Hawaii, and U.S. possessions.

PABX - Private Automated Branch Exchange - hardware that provides automatic (electro-mechanical or electronic) local circuit switching on a customer's premises.

PAD - Packet Assembler-Disassembler - a device that enables DTE not equipped for packet switching operation to operate on a packet switched network.

PBX - Private Branch Exchange - hardware which provides local circuit switching on the customer premise.

PCM - Pulse-Code Modulation - modulation involving conversion of a waveform from analog to digital form through coding.

PDN - Public Data Network - a network established and operated by a recognized private operating agency, a telecommunications administration, or other agency for the specific purpose of providing data transmission services to the public.

Peripherals - Any unit of input/output equipment in a computer system, exclusive of the central processing unit.

PPM - Pulse Position Modulation.

Private Network - A network established and operated for one user or user organization.

Programmers - Persons mainly involved in designing, writing, and testing of computer software programs.

Protocols - The rules for communication system operation that must be followed if communication is to be effected. Protocols may govern portions of a network or service. In digital networks, protocols are digitally encoded as instructions to computerized equipment.

Public Network - A network established and operated for more than one user with shared access, usually available on a subscription basis. See related international definition of PDN.

Scientific Computer System - A computer system designed to process structured mathematics, such as Fast Fourier Transforms, and complex, highly redundant information, such as seismic data, sonar data, and radar, with large on-line memories and very high capacity throughput.

SDLC - Synchronous Data Link Control - IBM's data link control for SNA. Supports a subset of HDLC modes.

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SDN - Software-Defined Network.

Security - Physical, electrical, and computer (digital) coding procedures to protect the contents of computer files and data transmission from inadvertent or unauthorized disclosure to meet the requirements of the Privacy Act and national classified information regulations.

Service Delivery Point - The location of the physical interface between a network and customer/user equipment.

Simplex - Undirectional communications.

Smart Box - A device for adapting existing DTE to new network standards such as OSI. Includes PADs and protocol convertors, for example.

SNA - Systems Network Architecture-seven-layer communications architecture designed by IBM. Layers correspond roughly but not exactly to OSI model.

Software - Computer programs.

Supplies - Includes materials associated with the use or operations of computer systems, such as printer paper, keypunch cards, disk packs, and tapes.

Switched Circuit - Temporary connection between two network stations established through dial-up procedures.

Synchronous - Communications operation with separate, continuous clocking at both sending and receiving stations.

Systems Analyst - Individual who analyzes problems to be converted to a programmable form for application to computer systems.

Systems House - Vendor that acquires, assembles, and integrates hardware and software into a total turnkey system to satisfy the data processing requirements of an end user. The vendor also may develop systems software products for license to end users. The systems house vendor does not manufacture mainframes.

Systems Integrator - Systems house vendor that develops systems interface electronics, applications software, and controllers for the CPU, peripherals, and ancillary subsystems that may have been provided by a contractor or the government (GFE). This vendor may either supervise or perform the installation and testing of the completed system.

TI - Bell System designation for 1.544 mbps carrier capable of handling 24 PCM voice channels.

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TDM - Time Division Multiplexing - a multiplexing method that interleaves multiple transmissions on a single circuit by assigning a different time slot to each channel.

Token Passing - Local area network protocol which allows a station to transmit only when it has the "token," an empty slot on the carrier.

TOP - Technical Office Protocol - protocol developed by Boeing Computer Services to support administrative and office operations as complementary functions to factory automation implemented under MAP.

Turnkey System - System composed of hardware and software integrated into a total system designed to completely fulfill the processing requirements of a single application.

Twisted-Pair Cable - Communications cabling consisting of pairs of single-strand metallic electrical conductors, such as copper wires, typically used in building telephone wiring and some LANs.

Verification and Validation - Process for examining and testing applications and special systems software to verify that it operates on the target CPU and performs all of the functions specified by the user.

Voice-Grade - Circuit or signal in the 300-3300 Hz bandwidth typical of the public telephone system - nominally a 4 KHz user.

VTAM - Virtual Telecommunications Access Method - host-resident communications software for SNA networks.

C
Other Considerations

When questions arise as to the proper place to count certain user expenditures, INPUT addresses the questions from the user viewpoint. Expenditures then are categorized according to what the users perceive they are buying.

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Appendix: Glossary of Federal Acronyms

The federal government's procurement language uses a combination of acronyms, phrases, and words that is complicated by different agency definitions and interpretations. The government also uses terms of accounting, business, economics, engineering, and law with new applications and technology.

Acronyms and contract terms that INPUT encountered most often in program documentation and interviews for this report are included here, but this glossary should not be considered all-inclusive. Federal procurement regulations (DAR, FPR, FAR, FIRMR, FPMR) and contract terms listed in RFIs, RFPs, and RFQs provide applicable terms and definitions.

Federal agency acronyms have been included to the extent they are employed in this report.

A

Acronyms

AAS	Automatic Addressing System.
AATMS	Advanced Air Traffic Management System.
ACO	Administrative Contracting Offices (DCAS).
ACS	Advanced Communications Satellite (formerly NASA 30/20 GHz Satellite Program).
ACT-1	Advanced Computer Techniques (Air Force).
Ada	DoD High-Order Language.
ADA	Airborne Data Acquisition.
ADL	Authorized Data List.
ADS	Automatic Digital Switches (DCS).
AFA	Air Force Association.
AFCEA	Armed Forces Communications Electronics Association.
AGE	Aerospace Ground Equipment.
AIP	Array Information Processing.

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AIS	Automated Information System
AMPE	Automated Message Processing Equipment.
AMPS	Automated Message Processing System.
AMSL	Acquisition Management Systems List.
ANG	Army National Guard
AP(P)	Advance Procurement Plan.
Appropriation	Congressionally approved funding for authorized programs and activities of the Executive Branch.
APR	Agency Procurement Request.
ARPANET	DARPA network of scientific computers.
ASP	Aggregated Switch Procurement
ATLAS	Abbreviated Test Language for All Systems (for ATE-Automated Test Equipment).
Authorization	In the legislative process programs, staffing, and other routine activities must be approved by Oversight Committees before the Appropriations Committee will approve the money from the budget.
AUSA	Association of the U.S. Army.
AUTODIN	AUTOmatic DIgital Network of the Defense Communications System.
AUTOSEVOCOM	Automatic Secure Voice Communications Network
AUTOVON	AUTOmatic VOice Network of the Defense Communications System.
BA	Basic Agreement.
BAFO	Best And Final Offer.
Base level	Procurement, purchasing, and contracting at the military installation level.
BCA	Board of Contract Appeals.
Benchmark	Method of evaluating ability of a candidate computer system to meet user requirements.
Bid protest	Objection (in writing, before or after contract award) to some aspect of a solicitation by a valid bidder.
BML	Bidders Mailing List - qualified vendor information filed annually with federal agencies to automatically receive RFPs and RFQs in areas of claimed competence.
BOA	Basic Ordering Agreement.
B&P	Bid and Proposal - vendor activities in response to government solicitation/specific overhead allowance.
BPA	Blanked Purchase Agreement.
Budget	Federal Budget, proposed by the President and subject to Congressional review.
C^2	Command and Control.
C^3	Command, Control, and Communications.
C^4	Command, Control, Communications, and Computers.
C^3I	Command, Control, Communications, and Intelligence.
CAB	Contract Adjustment Board or Contract Appeals Board.
CADE	Computer-Aided Design and Engineering.
CADS	Computer-Assisted Display Systems.
CAIS	Computer-Assisted Instruction System.
CALS	Computer-Aided Automated Logistic System
CAPS	Command Automation Procurement Systems.

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CAS	Contract Administration Services or Cost Accounting Standards.
CASB	Cost Accounting Standards Board.
CASP	Computer-Assisted Search Planning.
CBD	Commerce Business Daily - U.S. Department of Commerce publication listing government contract opportunities and awards.
CBO	Congressional Budget Office.
CCEP	Commercial Comsec Endorsement Program
CCDR	Contractor Cost Data Reporting.
CCN	Contract Change Notice.
CCPDS	Command Center Processing and Display Systems.
CCPO	Central Civilian Personnel Office.
CCTC	Command and Control Technical Center (JCS).
CDR	Critical Design Review.
CDRL	Contractor Data Requirement List.
CFE	Contractor-Furnished Equipment.
CFR	Code of Federal Regulations.
CICA	Competition in Contracting Act
CIG	Computerized Interactive Graphics.
CIR	Cost Information Reports.
CM	Configuration Management.
CMI	Computer-Managed Instruction.
CNI	Communications, Navigation, and Identification.
CO	Contracting Office, Contract Offices, or Change Order.
COC	Certificate of Competency (administered by the Small Business Administration).
COCO	Contractor-Owned, Contractor-Operated.
CODSIA	Council of Defense and Space Industry Associations.
COMSTAT	Communications Satellite Corporation.
CONUS	CONtinental United States.
COP	Capability Objective Package.
COTR	Contracting Officer's Technical Representative.
CP	Communications Processor.
CPAF	Cost-Plus-Award-Fee Contract.
CPFF	Cost-Plus-Fixed-Fee Contract.
CPIF	Cost-Plus-Incentive-Fee Contract.
CPR	Cost Performance Reports.
CPSR	Contractor Procurement System Review.
CR	Cost Reimbursement (Cost Plus Contract).
CSA	Combat or Computer Systems Architecture.
C/SCSC	Cost/Schedule Control System Criteria (also called "C-Spec").
CWAS	Contractor Weighted Average Share in Cost Risk.
DAL	Data Accession List.
DAR	Defense Acquisition Regulations.
DARPA	Defense Advanced Research Projects Agency.
DAS	Data Acquisition System.
DBHS	Data Base Handling System.
DCA	Defense Communications Agency.

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DCAA	Defense Contract Audit Agency.
DCAS	Defense Contract Administration Services.
DCASR	DCAS Region.
DCC	Digital Control Computer.
DCP	Development Concept Paper (DoD).
DCS	Defense Communications System.
DCTN	Defense Commercial Telecommunications Network.
DDA	Dynamic Demand Assessment (Delta Modulation).
DDC	Defense Documentation Center.
DDL	Digital Data Link - A segment of a communications network used for data transmission in digital form.
DDN	Defense Data Network.
DDS	Dynamic Diagnostics System.
DECCO	DEfense Commercial Communications Office
DECEO	DEfense Communications Engineering Office
D&F	Determination and Findings - required documentation for approval of a negotiated procurement.
DIA	Defense Intelligence Agency.
DIF	Document Interchange Format, Navy-sponsored word processing standard.
DHHS	Department of Health and Human Services
DIDS	Defense Integrated Data Systems.
DISC	Defense Industrial Supply Center.
DLA	Defense Logistics Agency.
DMA	Defense Mapping Agency.
DNA	Defense Nuclear Agency.
DO	Delivery Order.
DOA	Department of Agriculture (also USDA).
DOC	Department of Commerce.
DOE	Department of Energy.
DOI	Department of Interior.
DOJ	Department of Justice.
DOS	Department of State.
DOT	Department of Transportation.
DPA	Delegation of Procurement Authority (granted by GSA under FPRs).
DPC	Defense Procurement Circular.
DQ	Definite Quantity Contract.
DQ/PL	Definite Quantity Price List Contract.
DR	Deficiency Report
DSCS	Defense Satellite Communication System
DSN	Defense Switched Network
DSP	Defense Support Program (WWMCCS).
DSS	Defense Supply Service.
DTC	Design-To-Cost.
ECP	Engineering Change Proposal.
ED	Department of Education.
EEO	Equal Employment Opportunity.
8(a) Set-Aside	Agency awards direct to Small Business Administration for direct placement with a socially/economically disadvantaged company.

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EMC	Electro-Magnetic Compatibility.
EMCS	Energy Monitoring and Control System.
EO	Executive Order - Order issued by the President.
EOQ	Economic Ordering Quantity.
EPA	Economic Price Adjustment.
EPA	Environmental Protection Agency.
EPMR	Estimated Peak Monthly Requirement.
EPS	Emergency Procurement Service (GSA) or Emergency Power System.
EUC	End User Computing, especially in DoD.
FA	Formal Advertising.
FAC	Facility Contract.
FAR	Federal Acquisition Regulations.
FCA	Functional Configuration Audit.
FCC	Federal Communications Commission.
FCDC	Federal Contract Data Center.
FCRC	Federal Contract Research Center.
FDPC	Federal Data Processing Center.
FEDSIM	Federal (Computer) Simulation Center (GSA).
FEMA	Federal Emergency Management Agency.
FFP	Firm Fixed-Price Contract (also Lump Sum Contract).
FIPS	NBS Federal Information Processing Standard.
FIPS PUBS	FIPS Publications.
FIRMR	Federal Information Resource Management Regulations.
FMS	Foreign Military Sales.
FOC	Final Operating Capability.
FOIA	Freedom of Information Act.
FP	Fixed-Price Contract.
FP-L/H	Fixed-Price - Labor/Hour Contract.
FP-LOE	Fixed-Price - Level-Of-Effort Contract.
FPMR	Federal Property Management Regulations.
FPR	Federal Procurement Regulations.
FSC	Federal Supply Classification.
FSG	Federal Supply Group.
FSN	Federal Supply Number.
FSS	Federal Supply Schedule or Federal Supply Service (GSA).
FSTS	Federal Secure Telecommunications System.
FT Fund	A revolving fund, designated as the Federal Telecommunications Fund, used by GSA to pay for GSA-provided common-user services, specifically including the current FTS and proposed FTS 2000 services.
FTPS	Federal Telecommunications Standards Program administered by NCS; Standards are published by GSA.
FTS	Federal Telecommunications System.
FTS 2000	Proposed replacement for the Federal Telecommunications System.
FY	Fiscal Year.
FYDP	Five-Year Defense Plan.
GAO	General Accounting Office.
GFE	Government-Furnished Equipment.

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GFM	Government-Furnished Material.
GFY	Government Fiscal Year (October to September).
GIDEP	Government-Industry Data Exchange Program.
GOCO	Government Owned - Contractor Operated.
GOGO	Government Owned - Government Operated.
GOSIP	Government Open Systems Interconnect Profile
GPO	Government Printing Office.
GPS	Global Positioning System.
GRH	Gramm-Rudman-Hollings Act (1985), also called Gramm-Rudman Deficit Control
GS	General Schedule.
GSA	General Services Administration.
GSBCA	General Services Administration Board of Contract Appeals.
HCFA	Health Care Financing Administration.
HHS	(Department of) Health and Human Services.
HPA	Head of Procuring Activity.
HSDP	High-Speed Data Processors.
HUD	(Department of) Housing and Urban Development.
ICA	Independent Cost Analysis.
ICAM	Integrated Computer-Aided Manufacturing.
ICE	Independent Cost Estimate.
ICP	Inventory Control Point.
ICST	Institute for Computer Sciences and Technology, National Bureau of Standards, Department of Commerce.
IDAMS	Image Display And Manipulation System.
IDEP	Interservice Data Exchange Program.
IDN	Integrated Data Network.
IFB	Invitation For Bids.
IOC	Initial Operating Capability.
IOI	Internal Operating Instructions.
IPS	Integrated Procurement System.
IQ	Indefinite Quantity Contract.
IR&D	Independent Research & Development.
IRM	Information Resource Manager.
IXS	Information Exchange System.
JOCIT	Jovial Compiler Implementation Tool.
JSIPS	Joint Systems Integration Planning Staff.
JSOP	Joint Strategic Objectives Plan.
JSOR	Joint Service Operational Requirement.
JUMPS	Joint Uniform Military Pay System.
LC	Letter Contract.
LCC	Life Cycle Costing.
LCMP	Life Cycle Management Procedures (DD7920.1).

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LCMS	Life Cycle Management System.
L-H	Labor-Hour Contract.
LOI	Letter of Interest.
LRPE	Long-Range Procurement Estimate.
LRIRP	Long-Range Information Resource Plan.
MAISRC	Major Automated Information Systems Review Council (DoD).
MANTECH	MANufacturing TECHnology.
MAPS	Multiple Address Processing System.
MAP/TOP	Manufacturing Automation Protocol/Technical and Office Protocol.
MASC	Multiple Award Schedule Contract.
MDA	Multiplexed Data Accumulator.
MENS	Mission Element Need Statement or Mission Essential Need Statement (see DD-5000.1 Major Systems Acquisition).
MILSCAP	Military Standard Contract Administration Procedures.
MIL SPEC	Military Specification.
MIL STD	Military Standard.
MIPR	Military Interdepartmental Purchase Request.
MOD	Modification.
MOL	Maximum Ordering Limit (Federal Supply Service).
MPC	Military Procurement Code.
MYP	Multi-Year Procurement.
NARDIC	Navy Research and Development Information Center.
NASA	National Aeronautics and Space Administration.
NBS	National Bureau of Standards.
NCMA	National Contract Management Association.
NCS	National Communications System; responsible for setting U.S. Government standards administered by GSA; also holds primary responsibility for emergency communications planning.
NICRAD	Navy-Industry Cooperative Research and Development.
NIP	Notice of Intent to Purchase.
NMCS	National Military Command System.
NSA	National Security Agency.
NSEP	National Security and Emergency Preparedness.
NSF	National Science Foundation.
NSIA	National Security Industrial Association.
NTIA	National Telecommunications and Information Administration of the Department of Commerce; replaced the Office of Telecommunications Policy in 1970 as planner and coordinator for government communications programs; primarily responsible for radio.
NTIS	National Technical Information Service.
Obligation	"Earmarking" of specific funding for a contract from committed agency funds.
OCS	Office of Contract Settlement.
OFCC	Office of Federal Contract Compliance.
Off-Site	Services to be provided near but not in government facilities.
OFMP	Office of Federal Management Policy (GSA).

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OFPP	Office of Federal Procurement Policy.
OIRM	Office of Information Resources Management.
O&M	Operations & Maintenance.
OMB	Office of Management and Budget.
O,M&R	Operations, Maintenance, and Readiness.
On-Site	Services to be performed on a government installation or in a specified building.
OPM	Office of Procurement Management (GSA) or Office of Personnel Management.
Options	Sole-source additions to the base contract for services or goods to be exercised at the government's discretion.
OSHA	Occupational Safety and Health Act.
OSI	Open System Interconnect
OSP	Offshore Procurement.
OTA	Office of Technology Assessment (Congress).
Out-Year	Proposed funding for fiscal years beyond the Budget Year (next fiscal year).
P-I	FY Defense Production Budget.
P3I	Pre-Planned Product Improvement (program in DoD).
PAR	Procurement Authorization Request or Procurement Action Report.
PAS	Pre-Award Survey.
PASS	Procurement Automated Source System.
PCO	Procurement Contracting Officer.
PDA	Principal Development Agency.
PDM	Program Decision Memorandum.
PDR	Preliminary Design Review.
PIR	Procurement Information Reporting.
PME	Performance Monitoring Equipment.
PMP	Purchase Management Plan.
PO	Purchase Order or Program Office.
POM	Program Objective Memorandum.
POSIX	Portable Open System Interconnect Exchange.
POTS	Purchase of Telephone Systems.
PPBS	Planning, Programming, Budgeting System.
PR	Purchase Request or Procurement Requisition.
PRA	Paperwork Reduction Act.
PS	Performance Specification - alternative to a Statement of Work, when work to be performed can be clearly specified.
QA	Quality Assurance.
QAO	Quality Assurance Office.
QMCS	Quality Monitoring and Control System (DoD software).
QMR	Qualitative Material Requirement (Army).
QPL	Qualified Products List.
QRC	Quick Reaction Capability.
QRI	Quick Reaction Inquiry.
R-I	FY Defense RDT&E Budget.
RAM	Reliability, Availability, and Maintainability.
RC	Requirements Contract.

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R&D	Research and Development.
RDA	Research, Development, and Acquisition.
RDD	Required Delivery Date.
RD&E	Research, Development, and Engineering.
RDF	Rapid Deployment Force.
RDT&E	Research, Development, Test, and Engineering.
RFI	Request For Information.
RFP	Request For Proposal.
RFQ	Request For Quotation.
RFTP	Request For Technical Proposals (Two-Step).
ROC	Required Operational Capability.
ROI	Return On Investment.
RTAS	Real Time Analysis System.
RTDS	Real Time Display System.
SA	Supplemental Agreement.
SBA	Small Business Administration.
SB Set-Aside	Small Business Set-Aside contract opportunities with bidders limited to certified small businesses.
SCA	Service Contract Act (1964 as amended).
SCN	Specification Change Notice.
SDN	Secure Data Network.
SEC	Securities and Exchange Commission.
SE&I	Systems Engineering and Integration.
SETA	Systems Engineering/Technical Assistance.
SETS	Systems Engineering/Technical Support.
SIBAC	Simplified Intragovernmental Billing and Collection System.
SIMP	Systems Integration Master Plan.
SIOP	Single Integrated Operations Plan.
SNAP	Shipboard Nontactical ADP Program.
Sole Source	Contract award without competition.
Solicitation	Invitation to submit a bid.
SOR	Specific Operational Requirement.
SOW	Statement of Work.
SSA	Source Selection Authority (DoD).
SSAC	Source Selection Advisory Council.
SSEB	Source Selection Evaluation Board.
SSO	Source Selection Official (NASA).
STINFO	Scientific and Technical INFOrmation Program - Air Force/NASA.
STU	Secure Telephone Unit.
SWO	Stop-Work Order.
Synopsis	Brief Description of contract opportunity in CBD after D&F and before release of solicitation.
TA/AS	Technical Assistance/Analysis Services.
TCP/IP	Transmission Control Protocol/Internet Protocol.

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TEMPEST	Studies, inspections, and tests of unintentional electromagnetic radiation from computer, communication, command, and control equipment that may cause unauthorized disclosure of information; usually applied to DoD and security agency testing programs.
TILO	Technical and Industrial Liason Office—Qualified Requirement Information Program - Army.
TM	Time and Materials contract.
TOA	Total Obligational Authority (Defense).
TOD	Technical Objective Document.
TR	Temporary Regulation (added to FPR, FAR).
TRACE	Total Risk Assessing Cost Estimate.
TRCO	Technical Representative of the Contracting Offices.
TREAS	Department of Treasury.
TRP	Technical Resources Plan.
TSP	GSA's Teleprocessing Services Program.
TVA	Tennessee Valley Authority.
UCAS	Uniform Cost Accounting System.
USA	U.S. Army.
USAF	U.S. Air Force.
USCG	U.S. Coast Guard.
USMC	U.S. Marine Corps.
USN	U.S. Navy.
U.S.C.	United States Code.
USPS	United States Postal Service.
USRRB	United States Railroad Retirement Board.
VA	Veterans Administration.
VE	Value Engineering.
VHSIC	Very High Speed Integrated Circuits.
VIABLE	Vertical Installation Automation BaseLine (Army).
VICI	Voice Input Code Identifier.
WBS	Work Breakdown Structure.
WGM	Weighted Guidelines Method.
WIN	WWMCCS Intercomputer Network.
WITS	Washington Interagency Telecommunications System.
WIS	WWMCCS Information Systems.
WS	Work Statement - Offerer's description of the work to be done (proposal or contract).
WWMCCS	World-Wide Military Command and Control System.

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B

General and Industry

ADAPSO	Association of Data Processing Service Organization, now the Computer Software and Services Industry Association.
ADP	Automatic Data Processing.
ADPE	Automatic Data Processing Equipment.
ANSI	American National Standards Institute.
BOC	BELL Operating Company.
CAD	Computer-Aided Design.
CAM	Computer-Aided Manufacturing.
CBEMA	Computer and Business Equipment Manufacturers Association.
CCIA	Computers and Communications Industry Association.
CCITT	Comite Consultaif Internationale de Telegraphique et Telephonique; Committee of the International Telecommunication Union.
COBOL	COmmon Business-Oriented Language.
COS	Corporation for Open Systems
CPU	Central Processor Unit.
DMBS	Data Base Management System.
DRAM	Dynamic Random Access Memory
EIA	Electronic Industries Association.
EPROM	Erasible Programmable Read-Only-Memory.
IEEE	Institute of Electrical and Electronics Engineers.
ISDN	Integrated Services Digital Networks.
ISO	International Organization for Standardization; voluntary international standards organization and member of CCITT.
ITU	International Telecommunication Union.
LSI	Large-Scale Integration.
MFJ	Modified Final Judgement.
PROM	Programmable Read-Only Memory.
RBOC	Regional Bell Operating Company.
UNIX	AT&T Proprietary Operating System.
UPS	Uninterruptable Power Source.
VAR	Value Added Retailer.
VLSI	Very Large Scale Integration.
WORM	Write-Once-Read-Many-Times.

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Appendix: Policies, Regulations, and Standards

A

OMB Circulars

A-11	Preparation and Submission of Budget Estimates.
A-49	Use of Management and Operating Contracts.
A-71	Responsibilities for the Administration and Management of Automatic Data Processing Activities.
A-76	Policies for Acquiring Commercial or Industrial Products and Services Needed by the Government.
A-109	Major Systems Acquisitions.
A-120	Guidelines for the Use of Consulting Services.
A-121	Cost Accounting, Cost Recovery, and Integrated Sharing of Data Processing Facilities.
A-123	Internal Control Systems.
A-127	Financial Management Systems.
A-130	Management of Federal Information Resources.
A-131	Value Engineering

B

GSA Publications

The FIRMR as published by GSA is the primary regulation for use by federal agencies in the management, acquisition, and use of both ADP and telecommunications information resources.

C

DoD Directives

DD-5000.1	Major System Acquisitions.
DD-5000.2	Major System Acquisition Process.
DD-5000.11	DoD Data Elements and Data Codes Standardization Program.
DD-5000.31	Policy and Procedures for the Management and Control of High-Order Languages and Mandate for Use of Ada Language for all DoDMission-Critical Applications.
DD-5000.35	Defense Acquisition Regulatory Systems.

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DD-5200.1	DoD Information Security Program.
DD-5200.28	Security Requirements for Automatic Data Processing (ADP) Systems.
DD-5200.28-M	Manual of Techniques and Procedures for Implementing, Deactivating, Testing, and Evaluating Secure Resource Sharing ADP Systems.
DD-7920.1	Life Cycle Management of Automated Information Systems (AIS).
DD-7920.2	Major Automated Information Systems Approval Process.
DD-7935	Automated Data Systems (ADS) Documentation.

D

Standards

ADCCP	Advanced Data Communications Control Procedures; ANSI Standard X3.66 of 1979; also NBS FIPS 71.
CCITT G.711	International PCM Standard.
CCITT T.0	International Standard for Classification of Facsimile Apparatus for Document Transmission Over Telephone-Type Circuits.
DEA-1	Proposed ISO Standard for Data Encryption Based on the NBS DES.
EIA RS-170	Monochrome Video Standard.
EIA RS-170A	Color Video Standard.
EIA RS-464	EIA PBX Standards.
EIA RS-465	Facsimile Standard; Procedures for Document Transmission in the General Switched Telephone Network.
EIA RS-232-C	EIA DCE to DTE Interface Standard Using a 25-Pin Connector; Similar to CCITT V-24.
EIA RS-449	New EIA Standard DTE to DCE Interface which Replaces RS-232-C.
FED-STD 1000	Proposed Federal Standard for Adoption of the Full OSI Reference Model.
FED-STD 1026	Federal Data Encryption Standard (DES) Adopted in 1983; also FIPS 46.
FED-STD 1041	Equivalent to FIPS 100.
FED-STD 1061	Group II Facsimile Standard (1981).
FED-STD 1062	Federal Standard for Group III Facsimile; Equivalent to EIA RS-465.
FED-STD 1063	Federal Facsimile Standard; Equivalent to EIA RS-466.
FED- STDs 1005, 1005A-1008	Federal Standards for DCE Coding and Modulation.
FIPS 46	NBS Data Encryption Standard (DES).
FIPS 81	DES Modes of Operation.
FIPS 100	NBS Standard for Packet-Switched Networks; Subset of 1980 CCITT X.25.
FIPS 107	NBS Standard for Local Area Networks, Similar to IEEE 802.2 and 802.3.
IEEE 802.2	OSI-Compatible IEEE Standard for Data-Link Control in Local Area Networks.
IEEE 802.3	Local Area Network Standard Similar to Ethernet.
IEEE 802.4	OSI-Compatible Standard for Token-Bus Local Area Networks.
IEEE 802.5	Local Area Networks Standard for Token-Ring Networks.

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MIL-STD-188-114C	Physical interface protocol similar to RS-232 and RS-449.
MIL-STD-1750A	Embedded system microchip architecture specification.
MIL-STD-1777	IP-Internet Protocol.
MIL-STD-1778	TCP - Transmission Control Protocol.
MIL-STD-1780	File Transfer Protocol.
MIL-STD-1781	Simple Mail Transfer Protocol (Electronic Mail).
MIL-STD-1782	TELNET - Virtual Terminal Protocol.
MIL-STD-1815A	Standard for the Ada Programming Language, February 1983.
MIL-STD 2167	Defense System Software Development.
X.21	CCITT Standard for Interface between DTE and DCE for Synchronous Operation on Public Data Networks.
X.25	CCITT Standard for Interface between DTE and DCE for Terminals Operating in the Packet Mode on Public Data Networks.
X.75	CCITT Standard for Links that Interface Different Packet Networks.
X.400	ISO Application-Level Standard for the Electronic Transfer of Messages (Electronic Mail).

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Appendix: Related INPUT Reports

A	
Annual Market Analyses	*U.S. Information Services Vertical Markets, 1987.*
	U.S. Information Services Cross-Industry Markets, 1987.
	Procurement Analysis Reports, GFY 1988-1992.
B	
Industry Surveys	*U.S. Information Services Industry, 1987.*
	Eighteenth Annual ADAPSO Survey of the Computer Services Industry, 1984.
	Directory of Leading U.S. Information Services Vendors, 1988.
C	
Market Reports	*Federal Software Markets, 1987-1992.*
	Federal Systems Integration Market, 1987-1992.
	Federal ADP Facilities Management Market, 1987-1992.
	Federal Telecommunications Market, 1987-1992
	Federal Government Processing Services Market, 1987-1992.
	Federal Office Information Systems Market, 1986-1991.
	U.S. Professional Services Market, 1987-1992

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F
Appendix: Agency Questionnaires

Confidential

INPUT Questionnaire—NASA Space Center **Catalog No.** FISSP-43

Study Title: *NASA Information Services Market, 1988-1993*

Study Code: G-NAS
Date: _____

Type of Interview:
_____ Buyer _____ Telephone
_____ User _____ On-Site
_____ Policy _____ Mail

Interviewer: _____
NASA Field Office: _____
Address: _____ **Oper. Type:** _____
_____ **Office Code:** _____
_____ **Function:** _____
_____ _____
Name: _____ **Title:** _____
Telephone Number: _____
Summary: _____
_____
_____
Reference: _____
_____
_____

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Confidential

NASA Information Services Market Questionnaire

For the purpose of this survey, we have defined information systems and services—"for ADP" as follows:

Operations and Maintenance – (also referred to as O&M) – Contracting (vendor) – staffed support of client ADP/telecommunications equipment on-site (on government property), in cases where the vendor does not manage the complete facility and the equipment and initial software suite may not have been provided by the vendor.

Processing Services – Include remote computing services, batch services, and processing facilities management.

Professional Services – Provide labor-intensive consulting, design, education and training, programming and analysis, management, and systems integration.

Professional Services Facilities Management (PSFM) – Also referred to as GOCO (Government-Owned, Contractor-Operated) services. The computing equipment is owned or leased by the client (government), not by the vendor. The vendor provides the staff to operate, maintain, repair, schedule, and manage the client's facility over a term of three to five years.

Programming and Analysis – Including system design, contract or custom programming, code conversion, independent verification and validation (also called "IV&V"), benchmarking.

Software Products – Include user purchases of applications and systems packages for in-house computer systems. Included are lease and purchase expenditure as well as expenditures for work performed by the vendor to implement and maintain the package at the user's sites.

Systems Integration – Services associated with systems design, integration of computer components, installation and government acceptance of ADP/telecommunications systems under projects called SE&I or SETA.

Telecommunications Networks – Electronic interconnection between sites or locations which may incorporate links between central computer sites and remote locations and switching and/or regional data processing modes. Network services typically are provided on a leased basis by a vendor to move data, voice, video, or textual information between locations.

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NASA Information Services Market Agency Questionnaire

1. Have you used any of the following ADP service categories within the past year? Will you be using them in the future?

		Yes	No	Future Yes	Future No	Why
a)	Professional Services	_____	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____	_____
c)	Software/ Related Services	_____	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____	_____
f)	Telecom.	_____	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____	_____

2. What percent of your total Information Services budget was spent on each of these categories last year?

		Percent Spent
a)	Professional Services	_____
b)	Facilities Management	_____
c)	Software/Related Services	_____
d)	Processing Services	_____
e)	Systems Integration	_____
f)	Telecommunications	_____
g)	Hardware	_____

3a. What is your average annual expenditure for Information Services?

$ _____.

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3b. What level of funding will you be receiving for FY88?

$M _____ FY89? $M _____

Has funding been increasing or decreasing?

_____

_____

4a. Do you anticipate any change in the amount of Information Services you will use in the next two to five years?

Yes _____ No _____

Why? _____

4b. What mission changes, if any, are driving a change in Information Services?

_____

_____

Other factors?

_____

_____

4c. In which of the following categories do you expect either an increase or decrease in the next two to five years, and can you estimate by what percent?

		Increase	Decrease	No Change	Percent Change
a)	Professional Services	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____
c)	Software/ Related Svcs.	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____
f)	Telecomm.	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____

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5a. What major computer systems and programs are presently operating at your site? Which do you expect to replace in the near future?

_____

_____

5b. Does your agency plan to add new in-house computers in the next five years?

Yes _____ No _____

5c. What kind of computers/systems will be added?

Mainframes _____ Micros _____

Supercomputers _____ Minis _____

5d. How does your agency plan to accomplish the change and/or addition of computer systems?

_____ Buy integrated system(s)
_____ Buy turnkey system(s)
_____ Buy hardware separately and use an integrated contractor
_____ Buy hardware separately and do integration in-house
_____ Move the applications to outside sources such as:

Other Agency Data Centers _____
Remote Computer Services (for instance, Teleprocessing Services Program) _____
Contractor-Owned Contractor-Operated Facilities _____
Government-Owned Contractor-Operated Facilities _____

_____ Other (specify) _____

6a. What types of applications have you contracted out to services vendors in the past year?

_____

6b. Has your agency completed any "mission-oriented" contracting for services?

Yes _____ No _____

If yes: Which type of applications? _____

7. Will your agency be adding any new systems integration projects or have they recently installed systems integration or turnkey systems projects?

_____

_____

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8. What would be the controlling criteria in selection of a contractor?

_____ Proposed Technical Solution
_____ Risk Containment Procedures
_____ Contract Type
_____ Initial Cost
_____ Life Cycle Cost
_____ Other _____

9. Which type of vendor or organization appears more desirable to performing services to your agency?

_____ Hardware Manufactures
_____ Professional Services
_____ Engineering and Construction
_____ Communications Vendors
_____ Aerospace (Divisions)
_____ Not-For-Profit
_____ Other (specify) _____

10. What type contract does your agency prefer for each type of information services category you use:

		Cost Plus	Fixed Price	Fixed Labor	Award Fee	Mix
a)	Professional Services	_____	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____	_____
c)	Software/ Related Services	_____	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____	_____
f)	Telecomm.	_____	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____	_____

11. When a commercial services contract is completed, do you usually transfer continued support in-house or leave support with contractors?

_____ In-House _____ Contractors

12a. Do you plan to convert any services to in-house?

Yes _____ No _____

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12b. Why? _____

_____

12c. Which applications? _____

_____

_____

13a. Do you plan to convert any in-house ADP support functions to outside contractor support?
Yes _____ No _____

13b. Why? _____

_____

13c. Which applications? _____

_____

14. What impact, if any, has Gramm-Rudman and other budget constraints had on your acquisitions of services?

_____

_____

15. What industry trends and other external factors might impact on your acquisitions of services?

_____

_____

16. Have standards activities (from NBS, the oversights, or such organizations as the ISO) had any impact on your acquisition of information services and computer systems? If so, how have they affected your plans?

_____

_____

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17a. What technological improvements do you see developing over the next 5 years in the following areas?

Telecommunications

_____

_____

End-User Computing

_____

_____

Information Management

_____

_____

17b. What other technological changes might alter the way your agency accomplishes information processing?

_____

_____

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Confidential

INPUT Questionnaire—NASA Headquarters **Catalog No.** FISSP-43A

Study Title: *NASA Information Services Market, 1988–1993*

Study Code: G-NAS
Date: _____

Type of Interview: _____ Buyer _____ Telephone
_____ User _____ On-Site
_____ Policy _____ Mail

Interviewer: _____

NASA Headquarter Office: _____

Address: _____ **Office Code:** _____

_____

_____

_____

Name: _____ **Title:** _____

Telephone Number: _____

Background Information: _____

_____

_____

1. Name of Program/Office: _____
2. Major Function of Office/Program: _____

_____

3. Organizational Overview/Position within NASA HDQ or Program Offices:

_____

_____

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Confidential

NASA Information Services Market Questionnaire

For the purpose of this survey, we have defined information systems and services—"for ADP" as follows:

Operations and Maintenance – (also referred to as O&M) – Contracting (vendor) – staffed support of client ADP/telecommunications equipment on-site (on government property), in cases where the vendor does not manage the complete facility and the equipment and initial software suite may not have been provided by the vendor.

Processing Services – Include remote computing services, batch services, and processing facilities management.

Professional Services – Provide labor-intensive consulting, design, education and training, programming and analysis, management, and systems integration.

Professional Services Facilities Management (PSFM) – Also referred to as GOCO (Government-Owned, Contractor-Operated) services. The computing equipment is owned or leased by the client (government), not by the vendor. The vendor provides the staff to operate, maintain, repair, schedule, and manage the client's facility over a term of three to five years.

Programming and Analysis – Including system design, contract or custom programming, code conversion, independent verification and validation (also called "IV&V"), benchmarking.

Software Products – Include user purchases of applications and systems packages for in-house computer systems. Included are lease and purchase expenditure as well as expenditures for work performed by the vendor to implement and maintain the package at the user's sites.

Systems Integration – Services associated with systems design, integration of computer components, installation and government acceptance of ADP/telecommunications systems under projects called SE&I or SETA.

Telecommunications Networks – Electronic interconnection between sites or locations which may incorporate links between central computer sites and remote locations and switching and/or regional data processing modes. Network services typically are provided on a leased basis by a vendor to move data, voice, video, or textual information between locations.

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Confidential

NASA Information Services Market Questionnaire

1. Have you used any of the following ADP service categories within the past year? Will you be using them in the future?

		Yes	No	Future Yes	Future No	Why
a)	Professional Services	____	____	____	____	_____
b)	Facilities Management	____	____	____	____	_____
c)	Software/ Related Services	____	____	____	____	_____
d)	Processing Services	____	____	____	____	_____
e)	Systems Integration	____	____	____	____	_____
f)	Telecom.	____	____	____	____	_____
g)	Hardware	____	____	____	____	_____

2. What percent of your total Information Services budget was spent on each of these categories last year?

		Percent Spent
a)	Professional Services	_____
b)	Facilities Management	_____
c)	Software/Related Services	_____
d)	Processing Services	_____
e)	Systems Integration	_____
f)	Telecommunications	_____
g)	Hardware	_____

3a. How does NASA's overall planning process support your IS modernization efforts?

_____

3b. What is your average annual expenditure for Information Services?

$ _____.

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3c. What level of funding will you be receiving for FY88?

$M _____ FY89? $M _____

Has funding been increasing or decreasing?

_____

_____

4a. Do you anticipate any change in the amount of Information Services you will use in the next two to five years?

Yes _____ No _____

Why? _____

4b. What mission changes or trends, if any, are driving a change in Information Services?

_____

_____

Other factors?

_____

_____

4c. In which of the following categories do you expect either an increase or decrease in the next two to five years, and can you estimate by what percent?

		Increase	Decrease	No Change	Percent Change
a)	Professional Services	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____
c)	Software/ Related Svcs.	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____
f)	Telecomm.	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____

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5a. What major computer systems and programs are presently operating at your site?

_____

_____

Which will be replaced over the next 5 years?

_____

_____

5b. Does your agency plan to add new in-house computers in the next five years?

Yes _____ No _____

5c. What kind of computers/systems will be added?

Mainframes _____ Micros _____

Supercomputers _____ Minis _____

5d. How does your agency plan to accomplish the change and/or addition of computer systems?

_____ Buy integrated system(s)
_____ Buy turnkey system(s)
_____ Buy hardware separately and use an integration contractor
_____ Buy hardware separately and do integration in-house
_____ Move the applications to outside sources such as:

Other Agency Data Centers	_____
Remote Computer Services (for instance, Teleprocessing Services Program)	_____
Contractor-Owned Contractor-Operated Facilities	_____
Government-Owned Contractor-Operated Facilities	_____

_____ Other (specify) _____

6a. What types of applications have you contracted out to services vendors in the past year?

_____

6b. Has your agency complete any "mission-oriented" contracting for services?

Yes _____ No _____

If yes: Which type of applications? _____

6c. Does your office support any agency-wide information systems?

Yes _____ No _____

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6d. Are there any other major NASA initiatives for FY1988-1993, for which your office will be a participant?

Yes _____ No _____

Which systems?

_____

_____

7. Will your agency be adding any new systems integration projects or have they recently installed systems integration or turnkey systems projects?

_____

_____

8. What would be the controlling criteria in selection of a contractor?

_____ Proposed Technical Solution
_____ Risk Containment Procedures
_____ Contract Type
_____ Initial Cost
_____ Life Cycle Cost
_____ Other _____

9. Which type of vendor or organization appears more desirable to performing services to your agency?

_____ Hardware Manufactures
_____ Professional Services
_____ Engineering and Construction
_____ Communications Vendors
_____ Aerospace (Divisions)
_____ Not-For-Profit
_____ Other (specify) _____

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10. What type contract does your agency prefer for each type of information services category you use:

		Cost Plus	Fixed Price	Fixed Labor	Award Fee	Mix
a)	Professional Services	____	____	____	____	____
b)	Facilities Management	____	____	____	____	____
c)	Software/ Related Services	____	____	____	____	____
d)	Processing Services	____	____	____	____	____
e)	Systems Integration	____	____	____	____	____
f)	Telecomm.	____	____	____	____	____
g)	Hardware	____	____	____	____	____

11. When a commercial services contract is completed, do you usually transfer continued support in-house or leave support with contractors?

____ In-House ____ Contractors

12a. Do you plan to convert any services to in-house?

Yes ____ No ____

12b. Why? _____

_____

12c. Which applications? _____

_____

13a. Do you plan to convert any in-house ADP support functions to outside contractor support?

Yes ____ No ____

13b. Why? _____

_____

13c. Which applications? _____

_____

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14. What impact, if any, has Gramm-Rudman and other budget constraints had on your acquisitions of services?

15. What industry trends and other external factors might impact on your acquisitions of services? (i.e., Ada, AI, teaming, mergers)

16. Have standards activities (from NBS, the oversights, or such organizations as the ISO) had any impact on your acquisition of information services and computer systems? If so, how have they affected your plans?

17a. What technological improvements do you see developing over the next 5 years in the following areas?

Telecommunications

End-User Computing

Information Management

17b. What other technological changes might alter the way your agency accomplishes information processing?

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18a. How does NASA relate headquarters IS oversight to field operating units?

18b. Is there any relationship between Headquarters IS oversight and headquarters IS operations?

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INPUT Questionnaire—NASA Headquarters – Planning Office

Catalog No. FISSP-43B

Study Title: *NASA Information Services Market, 1988–1993*

Study Code: G-NAS
Date: _____

Type of Interview: _____ Buyer _____ Telephone
_____ User _____ On-Site
_____ Policy _____ Mail

Interviewer: _____

NASA Headquarter Office: _____

Address: _____ **Office Code:** _____

_____

_____

_____

Name: _____ **Title:** _____

Telephone Number: _____

Background Information:

_____

_____

_____

1. Name of Program/Office: _____

2. Major Function of Office/Program: _____

_____

3. Organizational Overview/Position within NASA HDQ or Program Offices:

_____

_____

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NASA Information Services Market Questionnaire

For the purpose of this survey, we have defined information systems and services—"for ADP" as follows:

Operations and Maintenance – (also referred to as O&M) – Contracting (vendor) – staffed support of client ADP/telecommunications equipment on-site (on government property), in cases where the vendor does not manage the complete facility and the equipment and initial software suite may not have been provided by the vendor.

Processing Services – Include remote computing services, batch services, and processing facilities management.

Professional Services – Provide labor-intensive consulting, design, education and training, programming and analysis, management, and systems integration.

Professional Services Facilities Management (PSFM) – Also referred to as GOCO (Government-Owned, Contractor-Operated) services. The computing equipment is owned or leased by the client (government), not by the vendor. The vendor provides the staff to operate, maintain, repair, schedule, and manage the client's facility over a term of three to five years.

Programming and Analysis – Including system design, contract or custom programming, code conversion, independent verification and validation (also called "IV&V"), benchmarking.

Software Products – Include user purchases of applications and systems packages for in-house computer systems. Included are lease and purchase expenditure as well as expenditures for work performed by the vendor to implement and maintain the package at the user's sites.

Systems Integration – Services associated with systems design, integration of computer components, installation and government acceptance of ADP/telecommunications systems under projects called SE&I or SETA.

Telecommunications Networks – Electronic interconnection between sites or locations which may incorporate links between central computer sites and remote locations and switching and/or regional data processing modes. Network services typically are provided on a leased basis by a vendor to move data, voice, video, or textual information between locations.

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NASA Information Technology Questionnaire – Planning

1. **Planning Process**

a. Has NASA published any guidelines on Information Systems Planning (ISP)?

Yes _____ No _____

If yes, how may we obtain a copy?

_____

_____

b. Does NASA have a regular plan cycle with milestones, i.e., specific dates for specific things to take place?

Yes _____ No _____

If yes, what are those dates?

_____

_____

c. What is the relationship between Headquarters ISP activities and those at the Centers?

_____

_____

d. How would you characterize the level of decentralization of NASA ISP activities?

_____

_____

e. How do changes in mission affect IS plans?

_____

_____

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f. Are plans updated to reflect external pressures, such as Congressional funding decisions?

_____

_____

g. Do the Centers prepare their own plan independently?

Yes _____ No _____

h. To what extent are NASA program managers involved in the ISP process?

_____

_____

2. **Planning Contents**

a. Do IS plans reflect mission goals and objectives, or focus primarily on technology progress in NASA?

_____

_____

b. Can the public obtain a copy of NASA's most recent planning submission to GSA and OMB?

Yes _____ No _____

If so, how?

_____

_____

c. May we also obtain a copy of any planning documents prepared by the Centers?

Yes _____ No _____

d. If the plans are not available, can you summarize the contents?

_____

_____

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3. **Additional Contacts**

a. Can you suggest other personnel, either at Headquarters or the Centers, who might provide additional information on NASA's ISP process?

_____

_____

b. May I use your name?

Yes _____ No _____

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INPUT Questionnaire—NASA Headquarters – Administrator

Catalog No. FISSP-43C

Study Title: *NASA Information Services Market, 1988–1993*

Study Code: G-NAS
Date: _____

Type of Interview: _____ Buyer _____ Telephone
_____ User _____ On-Site
_____ Policy _____ Mail

Interviewer: _____

NASA Headquarter Office: _____

Address: _____ **Office Code:** _____

_____

_____

_____

Name: _____ **Title:** _____

Telephone Number: _____

Background Information: _____

_____

_____

1. Name of Program/Office: _____
2. Major Function of Office/Program: _____

_____

3. Organizational Overview/Position within NASA HDQ or Program Offices:

_____

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NASA Information Services Market Questionnaire

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Programming and Analysis – Including system design, contract or custom programming, code conversion, independent verification and validation (also called "IV&V"), benchmarking.

Software Products – Include user purchases of applications and systems packages for in-house computer systems. Included are lease and purchase expenditure as well as expenditures for work performed by the vendor to implement and maintain the package at the user's sites.

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NASA Headquarters – Administrator Questionnaire

1. Which ADP service categories does NASA currently utilize most (Rank #1, 2 & 3)

a) Professional Services _____

b) Facilities Management _____

c) Software/Related Services _____

d) Processing Services _____

e) Systems Integration _____

f) Telecom. _____

g) Hardware _____

2. What percent of your total Information Services budget was spent on each of these categories last year?

Percent Spent

a) Professional Services _____

b) Facilities Management _____

c) Software/Related Services _____

d) Processing Services _____

e) Systems Integration _____

f) Telecommunications _____

g) Hardware _____

3a. What is NASA's average annual expenditure for Information Services?

$ _____.

3b. What level of funding will you be receiving for FY88?

$M _____ FY89? $M _____

Has funding been increasing or decreasing?

_____

_____

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4a. Do you anticipate any change in the amount of Information Services you will use in the next two to five years?

Yes _____ No _____

Why? _____

4b. What mission changes, if any, are driving a change in Information Services?

_____

_____

Other factors?

_____

_____

5a. How does NASA's overall planning process support the agency's IS modernization efforts?

_____

_____

_____

5b. What mechanisms are in place to receive and disseminate information from the research centers and space flight centers for planning purposes?

_____

_____

6a. How does NASA relate headquarters IS oversight to field operating units?

_____

_____

6b. Is there any relationship between Headquarters IS oversight and headquarters IS operations?

_____

_____

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7. For each space and research center, please identify one major computer system or program which best typifies that center's usage of Information Technology?
Johnson:

Ames:

Marshall:

Langley:

Goddard:

Lewis:

Kennedy:

Jet Propulsion:

(NOTE: How might information on those systems be obtained? List of sources available to public and points of contact).

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8. Which centers are projected to be contacting the largest share of the I.T. budget for FY89? For which programs?

9a. What do you view as the three most significant major NASA initiatives for FY 1988-1992?

9b. Which center will play the most important role for each program?

Program	Center
1.	1.
2.	2.
3.	3.

10a. How has systems integration aided in the completion of NASA's missions and objectives?

10b. Do you see it continuing to play an important role?

11a. How did "mission-oriented" contracting come about? (Historic information).

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11b. What types of applications are being contracted out under "mission-oriented" contracts?

12. What types of applications are being supported by each kind of computer/system used?

a) Mainframe:

b) Supercomputer:

c) Microcomputer:

d) Minicomputer:

13. Which type of contract do you expect to dominate for information services contracts in the next 2-3 years?

Cost Plus	Fixed Price	Fixed Labor	Award Fee	Mix
_____	_____	_____	_____	_____

Why?

What effect will this have on industry?

14a. What legislation has impacted NASA most significantly over the past 2 years?

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14b. What future legislation do you see influencing NASA's use of information technology? (Computer Security, Gramm-Rudman, etc.)

15. How will technological improvements in each of these areas alter the way NASA accomplishes information processing?

AI: _____

Optical Disk Storage: _____

End-User Computing: _____

Information Management Systems: _____

Local Area Networks: _____

Fiber Optics: _____

Graphics: _____

What additional technological improvements do you see developing over the next 5 years that will impact NASA?

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G
Appendix: Industry Questionnaire

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INPUT Questionnaire—Industry

Catalog No. FISSP-44
Study Code: G-NAS
Date: _____

Study Title: *NASA Information Services Market*

Interviewer: _____

Type of Interview: _____ Technical _____ Telephone
_____ Marketing _____ On-Site
_____ Executive _____ Mail

Company/Div.: _____ **Address:**
Subsidiary: _____ _____
Branch: _____ _____
Office: _____ _____
Office Code: _____ _____
Name: _____ **Title:** _____
Telephone Number: _____
Summary: _____
_____
_____
Referrals: _____
_____
_____

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NASA Information Services Market Questionnaire

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Professional Services – Provide labor-intensive consulting, design, education and training, programming and analysis, management, and systems integration.

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NASA Information Services—Industry Questionnaire

1. Does your company now provide or plan to provide information services to NASA?

   Yes _____ No _____

2. What types of systems or services do you now provide or plan to provide?

		Yes	No	Future Yes	Future No	Why
a)	Professional Services	_____	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____	_____
c)	Software/ Related Services	_____	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____	_____
f)	Telecom.	_____	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____	_____

3a. What other categories, if any, of products or services would you add to our list?

_____

_____

3b. What are your current and future activities in these categories?

_____

_____

3c. In your opinion, which area provides the most attractive opportunities for your company in providing support to NASA?

_____

_____

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4a. Do you anticipate any change in the amount of contracted support you will provide to NASA in the next two to five years?

Yes _____ No _____

4b. (If yes)

In which of the following categories do you expect either an increase or decrease in the next two to five years, and can you estimate by what percent? (NASA only)

		Increase	Decrease	No Change	Percent Change
a)	Professional Services	_____	_____	_____	_____
b)	Facilities Management	_____	_____	_____	_____
c)	Software/ Related Svcs.	_____	_____	_____	_____
d)	Processing Services	_____	_____	_____	_____
e)	Systems Integration	_____	_____	_____	_____
f)	Telecomm.	_____	_____	_____	_____
g)	Hardware	_____	_____	_____	_____

5. What types of applications is NASA contracting for through vendors?

_____

_____

6. Have you ever acquired a contract for support functions which were previously done in-house by NASA?

Yes _____ No _____ Type Services _____

_____

7a. What differences do you see between marketing to NASA and the other sectors of the federal market for your products and services?

_____

_____

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7b. Does you company provide services to NASA as a subcontractor or as a "team" participant?

_____

_____

8. Has your company completed any "mission-oriented" contracting for services?

Yes _____ No _____

If yes: Which type of applications? _____

9. Will your company be adding any new systems integration projects or have you recently installed systems integration or turnkey systems projects at NASA? (Examples)

_____

_____

10. Which of the following contract types do you expect to dominate in the NASA Information Services Market over the next five years?

Cost Plus _____ Fixed Price _____
Mix of FP & CP _____ Other (specify) _____

Why?

_____

_____

Effect on industry vendors?

_____

_____

11. In your opinion, what has been NASA's controlling criteria in their selection of contractors? (Rank #1, 2 & 3)

_____ Proposed Technical Solution
_____ Risk Containment Procedures
_____ Contract Type
_____ Initial Cost
_____ Life Cycle Cost
_____ Other _____

Do you see this changing? _____

_____

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12. What do you believe vendors need to do over the next five years to make their products and services more valuable to NASA?

13. What industry trends will affect NASA's information Services Market?

Why?

14. In your opinion, what technical factors will increase or decrease NASA's spending on information services in the next two to five years?

Additional Comments:

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About INPUT

Company Profile

INPUT provides planning information, analysis, and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions.

Continuous-information advisory services, proprietary research/consulting, merger/acquisition assistance, and multiclient studies are provided to users and vendors of information systems and sevices (software, processing services, turnkey systems, systems integration, professional services, communications, and systems/software maintenance and support).

Many of INPUT's professional staff members have more than 20 years' experience in their areas of specialization. Most have held senior management positions in operations, marketing, or planning. This expertise enables INPUT to supply practical solutions to complex business problems.

Staff Credentials

Formed as a privately held corporation in 1974, INPUT has become a leading international research and consulting firm. Clients include more than 100 of the world's largest and most technically advanced companies.

INPUT's professional staff have backgrounds in marketing, planning, information processing, and market research in some of the world's leading organizations. Many of INPUT's professional staff have held executive positions in the following business sectors:

- Computer systems
- Software
- Turnkey systems
- Field service (customer service)
- Processing services
- Professional services
- Data processing
- Network services
- Communications

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Educational backgrounds include both technical and business specializations, and many INPUT staff hold advanced degrees.

Domestic and European Advisory Services

INPUT offers ten basic information services: eight covering U.S. information industry markets and two covering European information industry markets.

1. Market Analysis Program—U.S. (MAP)

Provides up-to-date U.S. information services market analyses, five-year forecasts, trend analyses, and sound recommendations for action. MAPS is designed to satisfy the planning and marketing requirements of current and potential information services vendors.

2. Market Analysis Program—Europe (MAPE)

Analyzes and forecasts European software and services markets. Clients receive timely planning information through research-based studies, conferences, client meetings, and continuous client support.

3. Vendor Analysis Program (VAP)

Is a comprehensive reference service covering more than 4,000 U.S. information services vendor organizations. VAP is often used for competitive analysis and prescreening of acquisition and joint venture candidates.

4. Electronic Data Interchange Program (EDIP)

Focusing on what is fast becoming a major computer/communications market opportunity, INPUT's EDIP keeps you informed. Through monthly newsletters, timely news flashes, comprehensive studies, a joint user/vendor conference, and telephone inquiry privileges, you will be informed and stay informed about the events and issues impacting this burgeoning market.

5. Systems Integration Program (SIP)

Focus is on the fast-moving world of systems integration, and the provision of complex information systems requiring multiple products and services. Covers this infant segment in-depth by tracking both the federal and commercial markets via monthly project profiles, market analysis reports, a monthly newsletter, seminars, conferences, a presentation, and hotline inquiry service privileges.

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6. Federal Information Systems and Services Program (FISSP)

Presents highly specific information on U.S. federal government procurement practices, identifies information services vendor opportunities, and provides guidance from INPUT's experienced Washington professionals to help clients maximize sales effectiveness in the federal government marketplace.

7. Information Systems Program (ISP)

Is designed for executives of small, medium, and large information systems organizations and provides crucial information for planning, procurement, and management decision making. The program examines new service offerings, technological advances, user requirements for systems and services, IS spending patterns, and more. ISP is widely used by both user and vendor organizations.

8. Integrated Communications Program (ICP)

Provides management insight to ensure effective use of telecommunications. This program provides a comprehensive set of services, including major vendor profiles, market/service trends assessment, service quality assessment, national service profiles for 40 countries, quarterly service news reports, a handbook of international public data networks, issue study reports, conferences, and hotline client inquiry services.

9. Customer Service Program—U.S. (CSP)

Provides customer service organization management with data and analyses needed for marketing, technical, financial, and organizational planning. The program pinpoints user perceptions of service received, presents vendor-by-vendor service comparisons, and analyzes and forecasts service markets for large systems, small systems, telecommunications systems, software maintenance, and third-party maintenance.

10. Customer Service Program—Europe (CSPE)

Parallels the U.S. Customer Service Program, dealing with comparable issues in European markets.

Merger & Acquisition Services

INPUT also offers merger and acquisition services that are tailor-made for your requirements. Our years of experience and data base of company information about information systems and services companies have helped many companies.

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Customized Advisory Services Available

In addition to standard continuous-information programs, INPUT will work with you to develop and provide a customized advisory service that meets your unique requirements.

An Effective Combination

INPUT'S Executive Advisory Services are built on an effective combination of research-based studies, client meetings, informative conferences, and continuous client support. Each service is designed to deliver the information you need in the form most useful to you, the client. Executive Advisory Services are composed of *varied combinations of the following* products and services:

Research-Based Studies
Following a proven research methodology, INPUT conducts major research studies throughout each program year. Each year INPUT selects issues of concern to management. Topical reports are prepared and delivered throughout the calendar year.

Information Service Industry Reports
INPUT's Executive Advisory Services address specific issues, competitive environment, and user expenditures relative to:

- Software
- Processing/Network Services
- Systems Integration
- Telecommunications Service
- Office Systems
- Professional Services
- Turnkey Systems
- Small-Systems Service
- Third-Party Maintenance
- Large-Systems Service

Industry Market Reports
Detailed analyses of market trends, forces driving the markets, problems, opportunities, and user expenditures are available for the following segments:

- Banking/Finance
- Discrete Manufacturing
- Distribution
- Education
- Federal/State and Local Government
- Insurance
- Medical
- Process Manufacturing
- Service Industry
- Telecommunications
- Utilities
- Accounting
- Education/Training
- Engineering/Scientific
- Human Resources
- Other Cross-Industry Markets
- Transportation

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Hotline: Client Inquiry Services
Daily, weekly, monthly, quarterly, and annual client planning questions are answered quickly and completely through use of INPUT's Client Hotline. Clients may call any INPUT office (California, New Jersey, Washington D.C., or London) during business hours or they may call a unique voicemail service to place questions after-hours. This effective Hotline service is the cornerstone of every INPUT Executive Advisory Service.

The Information Center
One of the largest and most complete collections of information services industry data, the Information Center houses literally thousands of up-to-date files on vendors, industry markets, applications, current/emerging technologies, and more. Clients have complete access to the Information Center. In addition to the information contained in its files, the center maintains an 18-month inventory of over 130 major trade publications, vendor consultant manuals, economic data, government publications, and a variety of important industry documents.

Access to INPUT Professional Staff
Direct access to our staff, many of whom have more than 20 years of experience in the information industry, provides you continuous research and planning support. When you buy INPUT, you buy experience and knowledge.

Annual Client Conference
Each year, you can attend INPUT's Annual Client Conference. This three-day event addresses the status and future of the information services industry, the competitive environment, important industry trends potentially affecting your business, the impact of new technology and new service offerings, and more.

You will attend with top executives from many of the industry's leading, fastest-growing, and most successful vendor companies, and with top Information Systems (IS) managers from some of the world's most sophisticated user organizations.

On-Site Presentation by INPUT Executive
Many of INPUT's Planning Services offer an informative presentation at your site. Covering the year's research, this session is held in the fourth quarter of each calendar year.

Proprietary Research Service

INPUT conducts proprietary research that meets the unique requirements of an individual client. INPUT's custom research is effectively used:

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For Business Planning
Planning for new products, planning for business startups, planning expansion of an existing business or product line—each plan requires reliable information and analysis to support major decisions. INPUT's dedicated efforts and custom research expertise in business planning ensure comprehensive identification and analysis of the many factors affecting the final decision.

For Acquisition Planning
Successful acquisition and divestiture of information services companies requires reliable information. Through constant contact with information services vendor organizations, continuous tracking of company size, growth, financials, and management "chemistry," INPUT can provide the valuable insight and analysis you need to select the most suitable candidates.

For the Total Acquisition Process
INPUT has the credentials, the data base of company information, and most importantly, the contacts to assist you with the total acquisition and/or partnering relationship processes:

- √ Due Diligence
- √ Schedules and Introduction
- √ Criteria & Definitions
- √ Retainer and Fee-Based
- √ Active Search

For Competitive Analysis
Knowing marketing and sales tactics, product capabilities, strategic objectives, competitive posture, and strengths and weaknesses of your competition is as critical as knowing your own. The career experience of INPUT's professionals, coupled with its collection and maintenance of current financial, strategic, tactical, and operational information about more than 4,000 active companies, uniquely qualifies INPUT to provide the best competitive information available today.

For Market and Product Analysis
Developing new products and entering new markets involves considerable investment and risk. INPUT regularly conducts research for clients to identify product requirements, market dynamics, and market growth.

More About INPUT...
- More than 5,000 organizations, worldwide, have charted business directions based on INPUT's research and analysis.
- Many clients invest more than $50,000 each year to receive INPUT's recommendations and planning information.

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- INPUT regularly conducts proprietary research for some of the largest companies in the world.
- INPUT has developed and maintains one of the most complete information industry libraries in the world (access is granted to all INPUT clients).
- INPUT clients control an estimated 70% of the total information industry market.
- INPUT analyses and forecasts are founded upon years of practical experience, knowledge of historical industry performance, continual tracking of day-to-day industry events, knowledge of user and vendor plans, and business savvy.
- INPUT analysts accurately predicted the growth of the information services market—at a time when most research organizations deemed it a transient market. INPUT predicted the growth of the microcomputer market in 1980 and accurately forecasted its slowdown in 1984.

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